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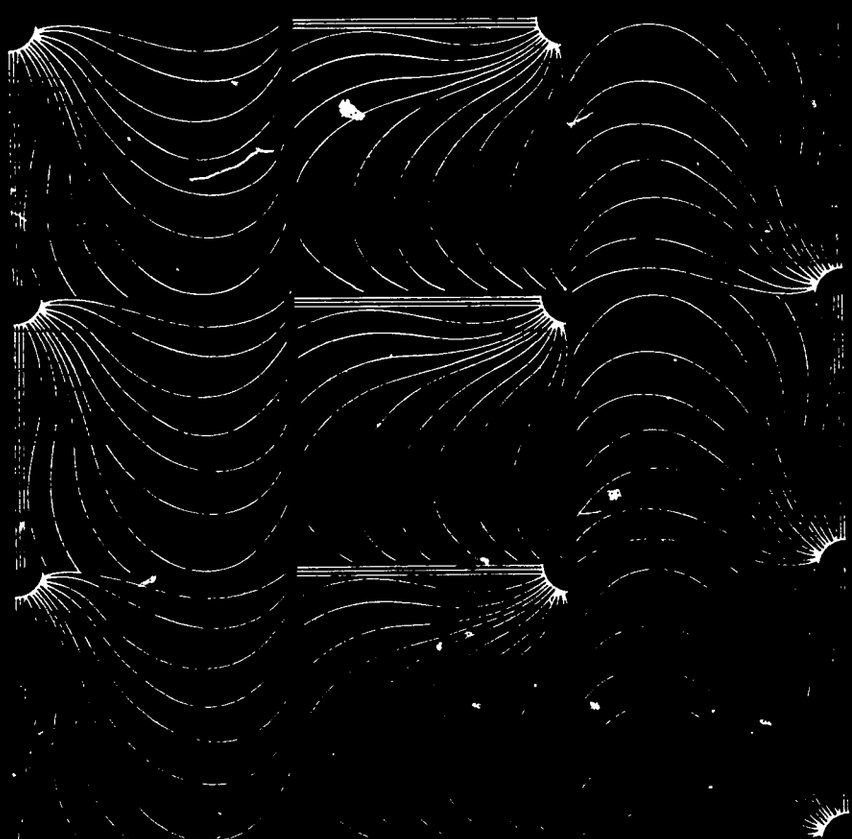
ABSTRACT

Presenting syntheses of research on effective instruction in 30 program areas, this paper is designed as a resource to assist teachers in expanding and refining their repertoire of teaching strategies and to guide instructional planning and decision making. For each program area, the paper presents a "finding" (a one-sentence statement on instructional strategies), a rationale (several paragraphs discussing the topic in more detail), and annotations of approximately two to six pertinent references. Topics discussed in the paper include: activating prior knowledge; classroom climate to support thinking; cooperative learning; critical thinking; discussion of controversial issues; graphic organizers; inquiry approach; metacognitive reading strategies; problem-solving approach in social studies; reading, writing, thinking connections; teaching scientific concepts; visual imagery; writing as a process; and writing to learn. (RS)

BETTER

THINKING AND LEARNING



BUILDING EFFECTIVE TEACHING THROUGH EDUCATIONAL RESEARCH

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INTRODUCTION

> ***Teachers are professionals and, as such, should engage in deliberate behaviors based on a rationale and monitored to their intended effects.***
>
> **from The Instructional Framework Task Force Report (January, 1988)**

The Division of Instruction initiated Project BETTER as part of its mission to promote effective instruction. Project BETTER – Building Effective Teaching Through Educational Research – was guided by three major objectives: 1) to identify current research on effective instruction, 2) to synthesize this research in the form of non-theoretical summaries, and 3) to deliver this information directly to practitioners. Staff specialists in the Division of Instruction, working with consultants, conducted comprehensive literature reviews and compiled syntheses in their respective program areas.

This publication presents the initial set of research findings. In addition to publications, the information obtained through Project BETTER is being incorporated into an electronic data base as part of the Division's Instructional Framework. The electronic format will allow a correlation between this research and other variables related to effective instruction, such as the characteristics of learners. The electronic data base is well suited to the expanding field of educational research, since emerging knowledge may be easily added and readily disseminated.

The information in this publication and in the data base is designed as a resource to assist teachers in expanding and refining their repertoire of teaching strategies and to guide instructional planning and decision making. It is not intended to prescribe a particular style of teaching or one "best" method. This resource provides a guide to teachers as they consider their curriculum objectives, the nature and needs of their students, their personal style of teaching, and their available instructional resources. The application of this knowledge will result in more effective teaching and more powerful learning.

Knowledge is power.

ACTIVATING PRIOR KNOWLEDGE

FINDING:

Teachers who activate relevant prior knowledge promote learning by enhancing comprehension of text, especially when information in the text is compatible with prior knowledge.

RATIONALE:

Activating relevant prior knowledge means calling to mind what is already known about a topic. Because comprehension is essentially a process by which meaning is constructed using background knowledge as well as information from the text and context, it is critical that readers are aware of what they already know about what they will read. Prior knowledge enables readers to predict the contents of text and confirm predictions through reading. Relating prior knowledge to text is one means of actively processing information from text. It also facilitates recall of information from text

This is a generic strategy for reading instruction which is an aspect of several more complex strategies such as reciprocal teaching, and the Directed Reading Thinking Activity. In addition general discussion questions and graphic organizers used before reading serve to help students call to mind relevant prior knowledge and use that information as they read.

Prior knowledge (in the form of schemata) influences our comprehension to a much greater degree than earlier research would have suggested....So powerful is the influence of prior knowledge on comprehension that Johnston and Pearson (1982; see also Johnston 1984) have found that prior knowledge of topic is a better predictor of comprehension than is either an intelligence test score or a reading achievement test score.

P. David Pearson

REFERENCES:

Anderson, R. C. and Pearson, P. D. (1984). A schema-theoretic view of basic processes in reading comprehension. In P. D. Pearson (Ed.) Handbook of reading research. New York: Longman.

The authors describe the role of prior knowledge in comprehension and learning and support their points with summaries of relevant research. They suggest implications of research findings for dealing with problem readers and further research.

Moore, D. W., Readence, J. E., and Rickelman, R. J. (1989). Prereading activities for content area reading and learning. Newark, DE: International Reading Association.

This book provides a review of the literature and research supporting the importance of prior knowledge and strategies for activating prior knowledge before reading.

Norris, S. P. and Phillips, L. M. (1987). Explanations of reading comprehension: Schema theory and critical thinking theory. Teachers College Record, 89, 287-306.

This article describes how two readers used prior knowledge, one successfully, one unsuccessfully, to construct meaning. The authors use a problem-solving model to characterize how readers use background knowledge.

ADVANCE ORGANIZERS

FINDING:

Teachers who introduce new materials to students through the use of advance organizers promote learning because advance organizers help students to organize, integrate, and retain materials to be learned.

RATIONALE:

Students are confronted on a daily basis with a great deal of unfamiliar material. Teachers can help students make sense out of this material if they take time at the outset of instruction to highlight the organizational and structural patterns of the new material and indicate how it relates to other material already learned. One means that research has demonstrated to be effective in rendering such assistance is the utilization of *advance organizers*, which are short sets of verbal or visual information presented prior to learning a larger body of content.

The intent of advanced organizers is to present students with context, not content, with conceptual frameworks, not specific detail. They can provide students with new organizational structures to guide the assimilation of the new content. For example, before students read about the French Revolution, the teacher might take time to present the conceptual scheme of the prototypical phases of a revolutionary movement.

Advance organizers also have been described as bridges from students' previous knowledge to whatever is to be learned. They can call forth general organizational patterns and relationships already in mind that students may not necessarily think to use in assimilating the new material. For example, before teaching the structure of state government, the teacher might have students recall the structure of the federal government with which they are already familiar and point out wherein the new structure to be learned will be alike or different from the structure already learned.

An advance organizer is always specific to the content and learners with which it is to be used. In general, however, advance organizers may be presented as written text, take a graphic form, utilize audiovisual supports, or be presented orally. Research studies have shown all to be effective. While studies have shown them to be effective with all grade and ability levels, the retention of lower ability students tends to profit the most. This is not surprising, for these students may be the most in need of organizational cues and the least able to generate them on their own. Finally, the studies indicate that the effectiveness of advance organizers is proportional to

the level of unfamiliarity, difficulty, and technicality of the material to be learned. This provides teachers with a rule of thumb to follow in deciding when to invest the planning time needed to develop a good advanced organizer to introduce a body of new information.

> ***Advanced organizers are especially effective for helping students learn the key concepts or principles of a subject area and the detailed facts and bits of information within these concept areas. The Advance Organizer is a highly effective instructional strategy for all subject areas where the objective is meaningful assimilation of those concepts, principles, and facts.***
>
> **M. L. Weil and J. Murphy**

REFERENCES:

Hartley, James and Davies, I.K. (1976). Pre-instructional strategies: the role of pretests, behavioral objectives, overviews, and advances organizers. Review of Educational Research, 46, 239-265.

This article describes a review of nearly 100 of the authors' studies from industrial training, film research, attitude change, and prose learning situations. The review concluded that the research evidence was favorable, but not overwhelming to the use of advance organizers.

Luiten, John, Ames, Wilbur, and Ackerson, Gary (1980). A meta-analysis of the effects of advance organizers on learning and retention. American Educational Research Journal, 17, 211-218.

This meta-analysis examined 135 studies of the facilitative effect of advanced organizers on learning and retention. The researchers also examined possible influencing variables such as subject area, grade level, subject ability level, and mode of presentation. The results showed advanced organizers to have facilitative effect on recall and comprehension.

Mayer, R.E. (1979). Can advance organizers influence meaningful learning? Review of Educational Research, 49. 371-383.

As a result of this review the author concluded advanced organizers do appear to have a positive influenceon learning outcomes.

Stone, C.L. (1983). A meta-analysis of advance organizer studies. Journal of Experimental Education, 54, 194-199.

The author examined 29 reports yielding 112 studies then analyzed by Glass' meta-analysis technique. Overall, advanced organizers were shown to be associated with increased learning and retention of material to be learned.

Weil, M.L. and Murphy, J. (1982). Instructional Processes. In H. E. Mitzel, (Ed.), Encyclopedia of Educational Research. NY: The Free Press, 892-893.

This chapter presents a summary of research findings regarding the effectiveness of advance organizers.

CLASSROOM CLIMATE TO SUPPORT THINKING

FINDING:

Teachers who establish classrooms characterized by an open, democratic climate promote learning because a such a classroom climate correlates significantly with the development of critical and creative thinking abilities.

RATIONALE:

In a classroom climate that is open and democratic, students are treated fairly and are free to express their opinions during discussion. Such a climate can prevail in classrooms that otherwise are traditional or innovative to varying degrees. The distinguishing and crucial factor is that in open, democratic classrooms students perceive their opinions to be solicited, accepted, and respected. It is in such classrooms that thinking is encouraged and nurtured.

In a classroom operated in a fundamentally democratic manner, students develop a trust in the teacher. This trust appears to generalize to students having greater trust in other authorities. Additionally, the effect of classroom climate on students' attitudes is felt in classroom and school life immediately and directly. Students in democratic settings exhibit more positive behavior and are less likely to engage in disruptive or violent actions. They appear more connected to the institution and show greater support for school policy. The evident effect of classroom climate on student attitudes makes a powerful statement about the conduct of classrooms to foster the type of thinking and attitudes relevant to a democracy. It also should cause serious introspection by teachers on their role as individuals in the development of thinking abilities and democratic values.

Closely related to teachers' behavior is the development of a classroom climate conducive to good thinking ... students cannot think well in a harsh, threatening situation or even in a subtly intimidating environment where group pressure makes independent thinking unlikely. Teachers can make their classrooms more thoughtful places by demonstrating in their actions that they welcome originality and differences of opinion.

Bob Marzano

REFERENCES:

Ehman, Lee H. (1980). The American school in the political socialization process. Review of Educational Research, 50, 99-119.

In this landmark study of political socialization in the United States, Ehman identified classroom climate as one of the few factors about schooling positively linked with positive political attitudes.

Leming, James S. (1985). Research on social studies curriculum and instruction: interventions and outcomes in the socio-moral domain. In W.B. Stanley, (Ed.), Review of Research in Social Studies Education: 1976-1983. Bulletin No. 75. Washington, D.C.: National Council for the Social Studies, 123-213.

A recent review of research on non-democratic and open, democratic classroom environments supports the linkage of open, democratic classrooms with positive political attitudes.

Van Sickle, R.L. (1983). Practicing what we teach: promoting democratic experience in the classroom. In M.A. Hepburn, (Ed.), Democratic Education in Schools and Classrooms. Bulletin No. 70. Washington, D.C.: National Council to the Social Studies, 49-66.

This essay describes the open, democratic classroom and discusses factors relevant to its maintenance.

CONCEPT DEVELOPMENT

FINDING:

Teachers who teach concepts inductively through the use of examples and non-examples promote learning because this strategy actively involves students in constructing a personal understanding of a new concept.

RATIONALE:

A concept is a set of specific objects, symbols, or events that share common characteristics, called critical attributes, and which are referred to by a particular name or symbol. For example, a family (concept) is a group of people who normally live together in a household (the attributes). One theory contends that students learn a concept by forming a prototype in their mind by focusing on an example of the concept provided them by a teacher, a book, or other source, and then by practicing the classification of additional cases as either examples or non-examples of the concept. Classification is accomplished by using the prototype, an example, as referrant. Experimental studies in concept learning support the efficacy of instructional models based on this theory.

A teaching strategy for concept learning based on the prototype theory would proceed as follows:

1. Begin by developing with the students a definition of the concept, stating it clearly in a manner appropriate to the learners. Review each of the attributes of the concept provided in the definition to make sure students are familiar with these terms. (While presenting the definition facilitates concept learning, it is not sufficient to provide a definition alone, for memorizing a definition can lead to mere verbalization of a series of words with no underlying grasp of meaning.)

2. Provide students with a clear example of the concept in whatever format is useful and appropriate, e.g. a picture, a short prose passage. Try to present an example that is vivid, has imagery, and possibly calls up familiar associations. Elaborate on the way the example fits the concept and its attributes.

3. Then engage students in a period of practice during which they are presented with a series of additional cases. Using the initial example as model, students must decide whether

each new case is an example of the concept or not. Provide feedback so students will know whether they are discriminating accurately.

It appears that during the process of discriminating between examples and non-examples students elaborate and complete the conceptual knowledge that becomes embedded in their memory. The number of examples and non-examples that needs to be presented to complete this process varies according to the nature of the learners. Generally, the more practice, the better. In this regard, it is appropriate to note that the important process of elaboration through multiple examples is exactly what is missing from most textbook presentations of concepts and is why students often have a difficult time learning key concepts in a meaningful way from textbook sources alone.

There is a great difference between knowing something and understanding it.

Charles Kettering

REFERENCES:

Joyce, B. and Weil, M. (1986). Models of Teaching (2nd ed.) Englewood Cliffs, N.J.: Simon and Schuster, 25 - 39.

This chapter provides a thorough discussion of concept development, including theory, research, and instructional practice.

Klausmeier, H.J. (1985). Educational Psychology. New York: Harper and Row.

Describes four stages of the development of a concept: (1) the concrete level, (2) the identity level, (3) classificatory level, and (4) the formal level.

Marzano, R. and Arredondo, D. (1986). Tactics for Thinking, Association for Supervision and Curriculum Development and Mid-Continent Regional Educational Laboratory, 16 - 20.

Presents instructional procedures for applying the Concept Attainment and Concept Development strategies in the classroom.

Martorella, P.H. (1982). Cognition research: some implications for the design of social studies instructional materials. Theory and Research in Social Education, 10, 1-16.

This article presents guidelines for concept development, especially regarding definitions and use of examples and non-examples. This work is based primarily on attribute theory as opposed to prototype theory.

Park, Ok-Choon (1984). Example comparison strategy versus attribute identification strategy in concept learning. American Educational Research Journal, 21, 145-162.

This study compares two concept teaching strategies to test their effectiveness. It concludes that "example comparison" strategy facilitates prototype formation in memory and resulted in higher degree of retention.

Stanley, W.B. (1985). Recent research on concept learnings: implications for social education. Theory and Research in Social Education, 12 (4), 57-74.

The author reviews recent research on concept structure and formation. Stanley criticizes the classical view based on attribute theory and contends new research supports prototype model of concept formation.

Tennyson, R. and Cocchiarella, M. (1986). An empirically based instructional design theory for teaching concepts. Review of Educational Research, 56, 40-71.

The authors present an instructional design theory based on use of best examples and discrimination among examples, non-examples for concept instruction.

Tennyson, R. and Park, O. (1980). The teaching of concepts: a review of instructional design research literature. Review of Educational Research, 50, 55-70.

This major review of research on conceptual development and instruction provides detailed recommendations for sequencing instruction to develop concepts.

Yoho, R.F. (1986) Effectiveness of four concept teaching strategies on social studies concept acquisition and retention. Theory and Research in Social Education, 14 (3), 211-223.

The author compares the effects of formal concept teaching strategies designed to facilitate concept formation in the context of ninth-grade world history classes. The strategy that emphasized prototype formation by focusing on a best example followed by contrasting it with additional examples was the most effective for both acquisition and retention.

COOPERATIVE LEARNING

FINDING:

Teachers who employ cooperative learning methods promote learning because these collaborative experiences engage students in an interactive approach to processing information, resulting in greater retention of subject matter, improved attitudes toward learning, and enhanced interpersonal relations among group members.

RATIONALE:

Cooperative learning may be broadly defined as any classroom learning situation in which students of all levels of performance work together in groups toward a common goal. In classrooms where collaboration is practiced, students pursue learning in groups of varying size: negotiating, initiating, planning and evaluating together. Rather than working as individuals in competition with every other individual in the classroom, they are given the responsibility of creating a learning community where all students participate in significant and meaningful ways. Although observations of cooperative classrooms may suggest that they are simply classrooms that use a lot of group work, they are much more than that. They are classes where students group together to accomplish significant tasks, and they are classrooms where students are likely to attain higher levels of achievement, to build cross-ethnic friendships, to experience enhanced self-esteem, and to display more positive attitudes toward school.

Cooperative learning requires that students work together to achieve goals which they could not achieve individually. The teacher's initial role, often in cooperation with the class, is that of "task setter." Carefully designed, meaningful tasks that require the active participation of each student in the group toward a common end are needed. Students must reach joint decisions in collaborative projects, must incorporate the contributions of all group members, and must create an effective working group.

As groups work through their tasks, the teacher is active in creating and maintaining an environment conducive to effective collaboration: attending to the physical arrangements, facilitating the recording of group progress and decisions, answering questions, and perhaps sitting in on a group which is foundering. In general, however, the teacher leaves the groupwork to the group, for it is in their struggles to work together and accomplish some task which is intrinsically important that they will learn the most. It is the need to discuss, to explicate positions, to consider alternative points of view, and to reach a working consensus with other students which makes the collaborative group such a stimulating environment.

Another benefit of collaborative learning is that students become increasingly able to manage

interpersonal action generally. They learn how to work productively with each other in dyads, triads, small task groups, committees, and special interest groups. And, much of our work lives we spend in group settings. The ability to manage time and human resources in small group settings is vital in and of itself.

A variety of formal cooperative learning models have been developed, such as STAD, TGT, JIGSAW I and II, CIRC, Co-Op, LEARNING TOGETHER, and GROUP INVESTIGATION. In addition to the formal models, a number of specific cooperative learning designs, such as think-pair-share, peer response groups for writing, paired problem solving in mathematics, reciprocal teaching in reading, group experiments in science, and debates and discussions in social studies and home economics have been successfully applied in the classroom. The selection of a particular model or design is influenced by the desired outcomes, the subject area, and the social skills of the students.

Research on cooperative learning is overwhelmingly positive, and the cooperative approaches are appropriate for all curriculum areas. The more complex the outcomes (higher-order processing of information, problem solving, social skills and attitudes) the greater are the effects.

Bruce Joyce

REFERENCES:

Bohlmeyer, E. M. & Burke, J. P. (1987). Selecting cooperative learning strategies: a consultantive study guide. School Psychology Review, 16 (1), 36-49.

Bohlmeyer and Burke survey nine techniques frequently associated with cooperative learning and classify them according to subject, nature of student interdependence, interaction among groups, evaluation, and requirements for implementation.

Hockaday, F. (1984). Collaborative learning with young children. Educational Studies, 10 (3), 237-42.

Hockaday reports that active group work holds great learning and social benefits for primary age children. She argues that collaborative learning need not wait till the later years.

Johnson, D. and Johnson, R. (1984). Cooperative small-group learning. Curriculum Report, 14 (1), 1-6.

Discussion of the underlying principles of cooperative learning along with a summary of the research regarding the results of its implementation.

Johnson, David W. and Johnson, Roger T. Having your cake and eating it too: maximizing achievement and cognitive-social development and socialization through cooperative learning. Paper presented at the 90th Annual Convention of the American Psychological Association, August 23-27, 1982.

The Johnsons, whose major area of interest is cooperative learning, find that having students work cooperatively in groups promotes the use of higher reasoning strategies and critical thinking in comparison with more individual or competitive strategies.

Johnson, R. et al. (1984). Circles of Learning: Cooperation in the Classroom. Alexandria, VA: Association for Supervision and Curriculum Development.

This book provides guidelines for initiating cooperative learning in the school and classroom.

Johnson, D., Maruyama, G., Johnson, R., Nelson, D and Skon, L. (1981). The effects of cooperative learning, competitive, and individualistic goal structures on achievement: a meta-analysis. Psychological Bulletin, 89, 7-62.

This meta-analysis of hundreds of studies comparing cooperative learning with more traditional learning designs (competitive and individualized) support the general superiority of cooperative learning. The positive cognitive and affective results, referred to in the Finding, have been reported for heterogenous groups of students in grades two through twelve in all major subject areas.

Slavin, Robert E. (1981). Synthesis of research on cooperative learning. Educational Leadership, 38 (8), 655-60.

This synthesis of research on cooperative learning points out that successful cooperative learning experiences require careful structuring by classroom teachers. In particular, two conditions appear to be prerequisites for maximum effects. First, cooperative learning groups must be rewarded for doing well as a group. Secondly, the group's success must depend upon the individual learning of each group member. Individual, as well as group accountability, must be structured into the cooperative learning design.

Slavin, Robert E. (1987). Cooperative Learning: Student Teams. What Research Says to the Teacher. Washington, D.C.: National Education Association.

A review of the reserach on cooperative learning along with a description of popular methods such as Teams-Games-Tournaments and Student Team Learning.

Staff. (1987). Cooperative learning in the urban classroom. Equity and Choice, 3 (2), 15-18.

Cooperative learning is represented as particularly suited for urban classrooms because of its positive effect on achievement and inter-ethnic friendships. A period of adjustment is required, however, as teachers and students grow into the new learning style.

CREATIVE PROBLEM SOLVING

FINDING:

Teachers who teach creative problem-solving strategies improve learning by providing students with general purpose problem-solving tools appropriate for a variety of situations.

RATIONALE:

Creativity and problem solving are important educational goals. Although there is not universal agreement about the best way to achieve these goals, several factors appear to be relevant. Knowledge of appropriate content is clearly an important component of effective problem solving. In addition, creative problem solvers display certain dispositions, such as the willingness to consider novel approaches. There also appears to be "creativity-relevant" strategies that cut across particular subject-matter boundaries and contribute to creative performance. Creative problem-solving training programs aim to develop these strategies.

Teachable strategies such as brainstorming, SCAMPER, and Synectics, have proven to be effective for generating novel ideas. Breaking one's perceptual set so as to allow different interpretations or understandings of a problem is another commonly taught strategy. A third example of a creative problem-solving strategy is known as suspending judgment, whereby the problem solver is careful to avoid premature rejection of potential solutions or premature acceptance of initial ideas.

A number of educational programs, such as CoRT, Just Think, Talents Unlimited, and Odyssey, include training in these, and other, creative problem-solving strategies. In addition, creative problem-solving competitions for individuals and teams are provided by such programs as Odyssey of the Mind, Future Problem Solving, and Invent America. All of these programs provide students with opportunities to employ creative problem solving strategies while working on a variety of open-ended, interdisciplinary problems.

Just as we can throttle our imagination, we can likewise accelerate it. As in any other art, individual creativity can be enhanced through the use of certain techniques.

Sidney Parnes

REFERENCES:

Amabile, T.M. (1983). The Social Psychology of Creativity. New York: Springer-Verlag.

Amabile surveys the research support for a variety of "creativity-relevant skills"—skills that improve creative performance across domains. The other two parts of her theory of creative performance are "domain-relevant skills," knowledge and skills in a particular field and "task motivation," intrinsic versus extrinsic motivation.

Baer, J.M., Jr. (1988) Long-term effects of creativity training with middle school students. Journal of Early Adolescence, 85 (2).

In a study of eighth-graders of above-average intelligence, those who received one week of intensive training in creative problem-solving techniques significantly out-scored a matched control group on a series of measures of creativity. These measures included divergent thinking tests (which emphasize fluency, flexibility, and originality of ideas) and assessments of convergent thinking (choosing appropriate, workable ideas and applying them). The effects of training were substantial and lasting (in posttests six months after the training).

Olton, R.M., & Crutchfield, R.S. (1969). Developing the skills of productive thinking. In P. Mussen, J. Langer, & M.V. Crutchfield (Eds.), New Directions in Developmental Psychology. New York: Holt, Rinehart and Winston.

A class of fifth-grade students trained in productive thinking out-scored a matched control group in tests of creative problem solving in a variety of domains.

Resnick, L.B. (1987). Education andLearning to Think. Washington, D.C.: National Academy Press.

Resnick reports soon-to-be-published results of recent evaluations by Covington of the Productive Thinking Program. "Students in the program become good at generating ideas and questions and increase their use of the planning strategies" (p. 22). The effects appear to be lasting, and there is evidence of transfer "to school tasks such as preparing a report or exhibit" (p. 23). She also summarizes results of studies of de Bono's CoRT program, which include increased fluency in the production of ideas, progress toward higher levels of abstraction, and taking more balanced views of problems.

CRITICAL THINKING

FINDING:

Teachers who develop critical thinking through direct instruction in appropriate skills, modeling of relevant dispositions, and practice with content applications promote learning since thinking critically about experience is integral to meaningful knowledge acquisition.

RATIONALE:

The development of critical, or reflective, thinking is an important educational goal. Unfortunately, commitment to this goal is frequently unsupported by classroom practice. The gap between intent and practice may be due in part to confusion over what critical thinking is and how it is developed. Recent research offers some insights into both.

Current views hold that critical thinking includes a set of skills, such as the ability to recognize bias, distinguish between relevant and irrevelant information, and establishing criteria. However, critical thinking may also be characterized as an attitude or a "mind set" that includes certain dispositions. Such attitudes or dispositions include the willingness to seek evidence for claims, consider opposing points of view, and change one's position when persuaded by evidence and reasons.

Critical thinking and its associated reasoning skills and dispositions are not likely to develop spontaneously. On the contrary, teachers must take a directive role in initiating and guiding critical thinking. Teachers can model critical thinking, then, by deliberately raising questions, drawing inferences, making observations, noting contradictions, proposing alternatives, and validating claims—and by prodding students to do likewise. Teachers can further model critical thinking by demonstrating the steps in their thinking as they engage in the above processes in response to specific contexts—and by prodding students to make explicit and reflect upon their individual thinking patterns also.

Research indicates that critical thinking skills are most effectively taught within the context of a subject area. Critical thinking is dependent on a sufficient base of knowledge. It is impossible to think critically about something of which one knows nothing. Furthermore, what constitutes critical thinking varies with the contexts provided by each form of knowledge and its disciplines. For example, the questions that are meaningful to ask and the proof of a valid answer are different in mathematics from those in art, in psychology from those in law, and in natural science from those in religion.

To paraphrase Catherine Cornbleth, the critical thinker engages in a dynamic process of raising and pursuing questions about their own and others' claims and conclusions, definitions and evidence, beliefs and reactions.

Although there are differences of opinion regarding the *best* way to develop the critical thinking of students, nearly all of the experts agree on the prominent role of the classroom teacher in structuring a classroom that encourages critical thinking. These teachers:

- create a classroom climate where students are encouraged to ask questions, pursue wonderings, explore, and collaborate. Students will be greater intellectual risk takers in a classroom where they feel confident and accepted;

- focus on active learning rather than passive knowledge acquisition. Students who engage exclusively in rote learning and are tested exclusively on mastery of unproblematic "facts" are less likely to develop the open-mindedness and reflectivity critical thinking demands.;

- demand that students elaborate, defend, and extend their positions, opinions, and beliefs. Students think more deeply when they investigate the paths thinking takes on the way to a conclusion. They also recognize the arguments underlying the positions others hold;

- use questioning and discussion effectively. The questions the teacher asks and that students ask of each other are the crux of critical thinking (see finding on Discussion);

- assess thinking appropriately. A stress on critical thinking may be all for nought if the regular testing and assessment procedures in the classroom, the school, and the district reward skills and dispositions not associated with critical thinking. Teachers must carefully consider the "reward" structure in the classroom and evaluate whether the attitudes, dispositions, and abilities they would want to foster in critical thinkers are those which are rewarded in the classroom.

- model the skills and dispositions of critical thinking. A wide range of behaviors are learned by observing and modeling the behavior of others. Through their day-to-day interactions wih students and staff, teachers can exemplify the cognitive and affective traits of the critical thinker.

In most classrooms, discussion, when it occurs, calls for simple recall. Serious intellectual discussion is rare.... how can the relatively passive docile roles of student prepare them to participate as informed, active and questioning citizens?

Ernest Boyer

25

REFERENCES:

Adler, M. (Ed.). (1984). ThePaideia Program. New York: Macmillan.

Adler, as part of his suggested reforms for schools, distinguishes between various styles of teaching: didactic, coaching, socratic. The coaching and socratic models are identified with the teaching behaviors which most effectively promote critical thinking. In this collection of articles, these behaviors are discussed.

Chambers, J.H. (1988). Teaching thinking throughout the curriculum—where else? Educational Leadership, 45 (7), 4-6.

Argues the philosophical case for teaching thinking in the context of disciplines.

Cornbleth, Catherine (1985). Critical thinking and cognitive process. In W.B. Stanley, (Ed.), Review of Research in Social Studies Education: 1976-1983. Bulletin No. 75. Washington, D.C.: National Council for the Social Studies, 11-63.

A brilliant essay summarizing current research and conceptual thinking about critical thinking.

Ennis, R. (1984). Goals for a Critical Thinking/Reasoning Curriculum. Urbana, IL: Illinois Thinking Project, University of Illinois.

Ennis defines critical thinking and illustrates how objectives relating to the development of abilities and dispositions related to critical thinking can be integrated across the curriculum and throughout the grades.

McPeck, J.E. (1981). Critical Thinking and Education. New York: St. Martin's Press.

Presents a detailed analysis of what critical thinking is and is not, and its implications for education.

Paul, R. (1984). Critical thinking: fundamental to education in a free society. Educational Leadership, Association for Supervision and Curriculum Development: Alexandria, VA.

Paul, who popularized the terms critical thinking in the "weak" sense and critical thinking in the "strong" sense, explains the connection between our national ideals of civic participation and the teaching of critical thinking. His article provides a justification for reorienting the curriculum toward more inclusion of critical thinking.

Walsh, D. & Paul, R. (n.d.) The Goal of Critical Thinking: From Educational Ideal to Educational Reality. Washington, D. C.: AFT.

Walsh and Paul have prepared an excellent report on critical thinking in our nation's schools. The report covers theory and research, instruction, evaluation, and administrative and system responsibility for program development.

❖ DIRECT TEACHING OF THINKING

FINDING:

Teachers who teach thinking skills and processes directly promote learning because such explicit instruction helps students to better understand and more effectively apply the types of thinking required by the curriculum.

RATIONALE:

Teachers interested in developing student thinking abilities have often stimulated their students through thought-provoking questions, discussions, and assignments. Activities such as these contribute to a thoughtful classroom. However, they may not necessarily result in the improvement of thinking for every student. For example, simply asking students "higher order" questions does not insure that they possess the thinking skills needed to answer them. Likewise, presenting students with a problem or a writing assignment does not *teach* the strategies employed by successful problem solvers or writers. And simply holding a classroom debate does not instruct students about *how* to structure or rebut an argument effectively. In each of these cases, a more direct approach may be needed to develop the specific skills and strategies of good thinking.

The Direct Instruction model emerged as an outgrowth of attempts to synthesize principles of effective teaching into a practical pedagogical model. Direct Instruction emphasizes active teaching and student "time on task." Elements of the model include explicit instruction in identified skills and concepts, guided practice with immediate feedback, frequent reviews and "checks" for understanding, and independent practice. A synthesis of classroom research (Rosenshine, 1976) confirms the effectiveness of these instructional elements in producing positive effects on student achievement. The need for a systematic instructional procedure linked to student achievement gains has led many educators to embrace the principles of direct instruction. It is in this context that a Direct Instruction approach is a valuable approach for the improvement of thinking.

Any identified thinking skill or process can be taught directly. To this end, Barry Beyer (1987) has identified the following six-step lesson model for introducing any thinking skill:

Step 1 - Introduce the Skill
Step 2 - Explain the Skill
Step 3 - Demonstrate (model) the Skill
Step 4 - Review What Was Done
Step 5 - Apply the Skill (guided practice)
Step 6 - Reflect on the Skill

In addition to this directive procedure, Beyer has also developed an inductive and a developmental lesson model for explicitly introducing a thinking skill. This approach has been used to teach such fundamental thinking skills as classifying, comparing, evaluating, hypothesizing, sequencing, and summarizing. Direct instruction can also be applied to more complex mental processes, such as decision making and problem solving. Other examples of explicit instruction may be observed in the "process approach" to the teaching of writing when students are directly taught specific thinking skills related to composing, such as the prewriting strategies of brainstorming and use of graphic organizers. Likewise, the contemporary view of reading encourages the explicit teaching of comprehension monitoring strategies when necessary.

While a Direct Instruction model can certainly be productively applied to the teaching of thinking, several caveats should be mentioned. First, we must be cautious not to fall into the reductionist trap, where dozens of micro thinking skills are "drilled and practiced" in artificial contexts without any bridging into meaningful content. Unfortunately, a number of workbooks filled with such exercises are available and frequently utilized by well-intentioned teachers interested in "teaching" thinking skills. The research on *transfer* (Perkins and Salomon, 1988) points out that, in general, students do not spontaneously apply thinking skills learned in one situation into new contexts. Thus, the direct teaching of thinking skills must include overt attention to transfer by helping students to make the connection of newly-learned thinking skills into various content areas as well as into "real world," out-of-school contexts. Secondly, as Lauren Resnick (1987) reminds us, higher order thinking is more heuristic than algorithmic. That is to say that while there may be certain identifiable elements involved in evaluation, argumentation, and problem solving, these thinking processes do not always follow a rigid, sequential series of steps. In addition, thinking is to some extent idiosyncratic, in that individuals employ different strategies for organizing information and solving problems. Teachers interested in teaching thinking directly must remember not to require all students to memorize the one, "correct" thinking procedure. Rather, they should take time to discuss the various ways in which students arrive at a solution, encourage students to reflect on their own thinking, and serve as models by reflecting on their own thinking process.

With these considerations in mind, the direct teaching of thinking holds a place among the various instructional approaches for improving student thinking. When it is clear that students do not understand the mental processes required for achievement of desired learning objectives, explicit teaching can help to render the invisible process of thinking more tangible and result in more effective processing of information for more meaningful learning.

The learning of complex thinking skills requires much more than completing worksheets, answering end-of-chapter questions, writing essays, or answering 'higher order,' teacher-generated questions. These activities may be useful, but they are not sufficient, singly or in combination, for learning a thinking skill to any degree of mastery. This is the case because such activities customarily focus on the

substantive products of using a skill and only indirectly on the skill being 'taught.' To bring students to the point where they are willing and able to use thinking skills independently in a variety of settings, teachers will have to teach these skills much more directly than most of them do now.

Barry Beyer

REFERENCES:

Anderson, E. (1985) Project IMPACT—A Summary of Outcomes in Four Schools. A report by The Orange County Board of Education, Costa Mesa, CA.

Project IMPACT program evaluation submitted to The Joint Dissemination Review Panel, National Diffusion Network, US Dept. of Education, Washington, D.C., 1983.

Project IMPACT (Improving Minimal Proficiencies by Activating Critical Thinking) was developed in the late 1970s and targeted for academically "at risk" students in the junior high grades (7,8 & 9). These students were being served in remedial programs due to their prior failure to demonstrate competency on the district proficiency tests. Project IMPACT was developed to provide a cognitive process orientation to remedial efforts by infusing the direct teaching of critical thinking skills into the curriculum. During the field test year, students from four different districts participated in the project. The evaluation employed a pre-test-post-test-control group design and proficiency tests in reading and mathematics (grades 7,8 and 9). Two instruments were utilized: 1. District Proficiency Tests in Reading and Math, and 2. The Cornell Critical Thinking Test, Level X. Students in the IMPACT groups significantly outperformed those in the control groups on all tests (DPT Reading and Math; Cornell Test). Significance was at the .01 level. Subsequent review and evaluation of this project by the U.S.O.E.'s Joint Dissemination Review Panel confirmed the effectiveness of Project IMPACT and led to subsequent adoption by the National Diffusion Network.

Beyer, B. (1987). Practical Strategies for the Teaching of Thinking. Allyn and Bacon: Boston, MA.

Beyer presents exceptionally detailed procedures for the direct teaching of thinking. Examples for teaching the skills of classifying and identifying bias are illustrated through deductive, inductive, and developmental lesson models.

Perkins, D. and Salomon, G. (1988), Teaching for transfer. Educational Leadership, Alexandria, VA., 22-32.

Reviews the research on the transfer of "process" skills and discusses implications for instructional practice.

Resnick, L. (1987). Education and Learning To Think. National Research Council, Washington, D.C., 3.

Resnick provides an excellent summary of current research related to the development of thinking abilities.

Rosenshine, B. (1976). "Classroom Instruction" in Gage, N. (ed.) Psychology of Teaching: The 77th Yearbook of the National Study of Education. Chicago, Illinois.

The author provides a description of a direct instruction model applied to the teaching of "basic" skills. Research suporting the efficacy of direct instruction is provided.

Worsham, A. and Austin, G. (1983). Effects of teaching thinking skills on SAT scores. Educational Leadership, Alexandria, VA., 50-51.

This article reports on the results of a doctoral dissertation by Antoinette Worsham in which she investigated the effects of a Language Arts thinking skills program on Scholastic Aptitude Test (SAT) performance. The study compared the SAT verbal scores of two matched groups of seniors from the same urban high school in Baltimore, Maryland. While both groups took the SAT, only the experimental group participated in the Think program. This participation consisted of direct instruction in thinking skills using the Think program two days per week during the language arts period. The students were involved with the program for three semesters, resulting in a total of approximately one hundred hours of thinking skills instruction.

Group comparability was established through ANOVA and t-test analyses on three pretest measures: the California Achievement Test (CAT) total verbal scores, and CAT reading comprehension and vocabulary subtest scores. Similar analyses were conducted on comparable SAT posttest measures: SAT total verbal scores and subtest scores in reading comprehension and vocabulary.

A mean increase in 42 points in the SAT total verbal scores was realized by the Think group. The difference was highly significant at the .0005 level. Significant differences also were found between the two subtest groups: .0019 for reading comprehension score increases and .0012 for vocabulary score increases.

DISCUSSION

FINDING:

Teachers who move classes beyond a recitation-mode into discussion promote learning because they encourage students to use dialogue as a tool to enhance thinking and understanding.

RATIONALE:

Given all the talk that goes on in all the classrooms in the world, one would imagine that a tremendous range of discussion practices would develop and flourish in schools. However, observers find that classroom discourse tends to be very much the same: teachers initiate exchanges with comments or questions; students respond with answers; teachers evaluate student responses. This pattern of initiating questions, responses, and evaluations (variously coded) is known as the *recitation model* and represents the underlying structure of most lessons.

Although useful for covering factual information quickly, recitation does not approach true discussion. Students have no opportunity to control the topic or to turn the talk to novel directions as suggested by their thinking. Teachers who move their classes beyond recitation into forms of talk which approach discussion help their students discover talk as a tool for thinking.

Helping students learn how to participate in good discussions is important. Students may come in to class with little experience of classroom discourse other than the recitation model. Therefore, teachers need to "get out of the way of student discussion" without retreating entirely. They should be ready to offer support to developing discussions so that all students can participate fruitfully.

Teachers can do several things to promote discussion. First, they can keep in mind the general direction in which they would move the class. Instead of the teacher (T) - student (S) - teacher (T) interchanges of recitation, they would move toward something like T-S-S-S-T-S-S-S-S on their way to student-directed discussions. Teachers can facilitate this by calling on several students at once, directing speakers to call on the next responder, and encouraging students not to raise hands to gain the floor but simply to be attentive to who wants to get in on the discussion. Also, to encourage students to listen carefully to other student speakers, the teacher can avoid repeating student comments while asking speakers to summarize the comments of the previous speaker. Finally, room arrangements can also help or hinder discussion. It is difficult even for experienced, active students to hold a discussion seated in rows. Circles, however,

encourage more involvement by all students in the classroom.

Finally, many observers of classroom interaction agree that the biggest impediment to discussion is the teacher. Teachers tend to ask factual questions where discussion is unnecessary and undesirable. They too often run the lesson at such a fast pace (one second or less of wait time) that student thinking never has a chance to take root. In their eagerness to "help the class get the point" of a student's comment, they may take the discussion away from the students in order to turn student comments toward teacher ends. However, teachers who reflect on their behavior in managing discussions have altered these behaviors and generally report that the class responds well to increased wait time, more student control, and student ownership of ideas. With patient scaffolding, both teacher and students can approach true discussion even in a recitation-centered class.

> ***All we know with certainty is that group work, including group discussion, enables—perhaps permits—us to decide some things with more wisdom than we could have mustered by ourselves. This is no small assurance. Few social procedures give more.***
>
> **Carroll Arnold**

REFERENCES:

Au, K. & Mason, J. M. (1981). Social organizational factors in learning to read: the balance of rights hypothesis. Reading Research Quarterly, 17, 115-52.

Au and Mason report evidence from the KEEP project that discussion practices which are more culturally congruent with the ways in which Hawaiian children experience discussion in their home community promote reading achievement. They suggest views of classroom interaction helpful for all teachers.

Barnes, D. (1976). From Communication to Curriculum. London: Penguin.

This classic text on classroom communication viewed as curriculum speaks powerfully to the notion of "exploratory talk," or open discussion, as a mode of learning and problem-solving.

Dillon, D. (1983). Using questions to foil discussion. Teaching and Teacher Education, 1, 109-121.

Dillon examines how constricting teacher questions coupled with fast paced lessons stifle the development of discussions in classrooms.

Rosenfeld, P, Lambert, N. M. & Black, A. (1985). Desk arrangement effects on pupil classroom behavior. Journal of Educational Psychology, 77, 101-108.

Studies with three fifth grade classrooms brainstorming topics for writing compared the effects of arranging desks in rows, clusters, and a circle. The circle produced the least hand raising and the most on task comments with the least pupil withdrawal.

Rowe, M. B. (1985). Wait time: slowing down may be a way of speeding up! Journal of Teacher Education, 37, 43-50.

Rowe reports that by increasing wait time teachers can create discussions where students share what she believes are the essential roles in any discussion: structuring, soliciting, responding, and reacting.

❖ DISCUSSION OF CONTROVERSIAL ISSUES

FINDING:

Teachers who engage high school students in discussions of controversial issues promote learning because such discussions contribute to the development of critical thinking.

RATIONALE:

Research points to the years of adolescence as a time of dramatic growth and change in political thought. Several factors appear to influence this development. One is a change in the adolescent's quality of thinking, including marked development of the ability to perceive several points of view, to recognize cause and effect, and to utilize hypothetical reasoning. Another factor is the adolescent's ability and interest in wrestling intellectually with questions of right and wrong. Also social maturation leads the adolescent to a greater sense of autonomy and a desire to take on adult roles. This developmental portrait suggests that the school should be concerned with helping youth organize and clarify their political and philosophical thought regarding controversial issues.

For the schools to perform this role successfully, two bodies of research suggest complementary, if not actually identical, practices which appear relevant. First is the politial socialization research that has investigated the effects of schools on students' political attitudes. These studies have concluded that the formal school curriculum not surprisingly transmits political information successfully, but generally appears to have little impact on shaping political attitudes. There is one variant to this conclusion, however, and that is some studies have demonstrated that when a teacher regularly incorporates free and open discussion of controversial issues into the course, then students' political attitudes are changed in positive ways. This research supports the long-held perception of many teachers that discussion of controversial issues should be integral to a comprehensive program in citizenship education.

A second body of research has investigated the development of students' moral reasoning, which is linked to the development of their philosophical reasoning and to their understanding of law as well. This research has sought to discover how best to advance students' moral thinking to the higher levels of principled reasoning. This is a task with particular relevance for social studies, science, and literature teachers, especially

in high schools, because a grasp of principled reasoning is prerequisite to appreciating, understanding, and applying the moral principles and values embedded in American democracy. These studies have concluded that the level of students' moral reasoning can be raised incrementally by engaging students in direct discussion of controversial issues and moral dilemmas. Opportunities for such discussions emerge naturally during the exploration of issues related to science, technology, and society. Likewise, the use of both hypothetical and historical dilemmas in the context of social studies and literature courses stimulates an examination of underlying ethical principles.

Research cautions, however, that to achieve their goals discussions of controversial issues must meet several conditions:

1. Discussion groups should be heterogeneous according to a range of viewpoints represented and to varying levels of sophistication in moral reasoning.
2. The issue under discussion should be truly open, without a pre-ordained conclusion. The floor should be open to all participants, and the teacher and students should be open-minded and respectful of divergent points of view.
3. Discussions should be civil exchanges during which participants practice the constraints of civilized, yet spirited discourse.
4. Discussions should be true exchanges, with all participants communicating actively about the opinions expressed and especially the reasoning given to support them.

Managing such discussions is no easy task, especially for teachers more experienced and perhaps more comfortable with didactic instruction.

> ***The goal of education should be to produce critical thinkers in the* strong sense. *Strong sense critical thinkers are those who use certain intellectual skills (such as clarifying issues, detecting faulty reasoning, etc.) in the pursuit of certain values (such as truth, open- or fair-mindedness, rationality, clarity, autonomy, and self-criticism).***
>
> **Richard Paul**

REFERENCES:

Adelson, Joseph (1971). The political imagination of the young adolescent. Daedalus, 100, 1013-1050.

Adelson presents a psychological portrait of the development of political thinking in adolescence based on interviews with 450 adolescents in 3 countries, some as part of a longitudinal study on growth and development.

Beyer, B.K. (1976). Conducting moral discussions in the classroom, Social Education, 40, 194-202.

Beyer discusses objectives, materials, and strategies for discussing moral dilemma discussions in classroom settings.

Dillon, J.T. (1984). Research on questioning and discussion. Educational Leadership, 42 (3), 50-56.

Dillon summarizes procedures for leading effective discussions. Recognizes paucity of research to offer secure guidelines.

Ehman, L.H. (1980). The american school in the political socialization process. Review of Educational Research, 50, 99-119.

Ehman, L.H. (1980). Changes in high school students' political attitudes as a function of social studies classroom climate. American Educational Research Journal, 17, 253-265.

Both studies represent the author's political socialization investigations from which he concludes a tentative support for incorporating controversial issues discussions in Social Studies Classrooms.

Goldenson, D.R. (1978). An alternative view about the role of the secondary school in political socialization: a field experimental study of the development of civil liberties attitudes. Theory and Research in Social Education, 6 (1), 44-69.

In this study significant changes in students' political attitudes were affected by involving them in discussions of controversial civil liberties cases.

Leming, J.S. (1985). Research on social studies curriculum and instruction: interventions and outcomes in the socio-moral domain. In W.B. Stanley, (Ed.), Review of Research in Social Studies Education: 1976-1983. Bulletin No. 75. Washington, D.C.: National Council for the Social Studies, 123, 213.

This review offers one of the most recent and comprehension evaluations of research on affective education in the social studies field.

Lockwood, A.L. (1978). The effects of values clarification and moral development curricula on school age subjects: A Critical Review of Recent Research. Review of Educational Research, 48, 325-364.

Lockwood presents favorable evaluation of using moral dilemma discussions to raise moral maturity scores of students in experimental situations.

EXPLICIT INSTRUCTION IN READING STRATEGIES

FINDING:

Teachers who provide students with information about reading skills and strategies through direct explanation and the gradual transfer of responsibility help their students become independent learners because they provide both the means and the motivation for becoming better readers.

RATIONALE:

Competent readers are not only skilled but strategic. That is, they have a repertoire of reading behaviors that they can consciously apply in a variety of situations for a variety of purposes. In order to be able to use a strategy students need to know what the behavior is, how to apply it, why it works, and in what situation it should be used. This knowledge about a reading behavior and the ability to select and apply it differentiates a strategy from a skill.

Explicit instruction in reading strategies should include modeling the strategy with explanations, metaphors, analogies, and think alouds of the strategy. This has been described as "scaffolded instruction" since it provides initial support, like a scaffold, for students as they build the ability to use a strategy. As students build a strategy into their repertoire, the scaffolding becomes less necessary. The teacher provides less direction and feedback and students assume greater responsibility for strategy applications.

There are several instructional approaches that help teachers provide explicit instruction in reading strategies. One approach is *think alouds*. Think alouds are a means of making thinking public and modeling cognitive processes. Another approach is *reciprocal teaching*. This approach provides a framework for direct instruction and transfer of ownership of strategies from the teacher to students. Finally, there is the *cooperative learning* approach. This is one way of allowing students to help each other in applying strategies to diverse materials in various contexts.

Declarative, procedural, and conditional knowledge are necessary ingredients for strategic behavior. Students can learn about these features of reading by direct instruction as well as by practice. Part of a teacher's job is to explicate strategies for reading so that students will perceive them as useful and sensible.

Scott Paris

REFERENCES:

Jones, B. F. (1986). Quality and equality through cognitive instruction. Educational Leadership, 43, 4-11.

This article provides a rationale for direct instruction in cognitive strategies that includes higher level thinking and provides growth in all levels of thinking for all levels of students.

Paris, S. G. (1986). Teaching children to guide their reading and learning. In Raphael, T. E. (Ed.), The contexts of school-based literacy, (pp. 115-130). New York: Random House.

This chapter provides a rationale for direct instruction in reading strategies and describes a program (Informed Strategies for Learning) to provide direct instruction in comprehension that includes declarative, procedural, and conditional information about strategies.

Roehler, L. R., Duffy, G. G., and Meloth, M. S. (1984). What to be direct about in direct instruction in reading: Content-only versus process-into-content. In Raphael, T. E. (Ed.), The contexts of school-based literacy, (pp. 79-95). New York: Random House.

This chapter argues for direct instruction in reading processes and provides examples of that type of instruction with particular references to low-aptitude students.

GRAPHIC ORGANIZERS

FINDING:

Teachers who utilize graphic organizers with their students promote learning because knowledge that is organized into holistic conceptual frameworks is more easily remembered and understood than unstructured bits of information.

RATIONALE:

Graphic organizers provide a visual, holistic representation of facts and concepts and their relationships within an organized frame. They have proven to be effective tools to aid learning and thinking by helping students and teachers to represent abstract information in more concrete form, depict relationships among facts and concepts, relate new information to prior knowledge, and organize thoughts for writing. Graphic organizers exist in a variety of forms. Perhaps the most widely known is the *web*. Other types of graphic organizers include the *concept map, sequence chain, story map, main idea table, flowchart, matrix*, and *venn diagram*.

Graphic organizers may be productively utilized **before** instructional activities, such as reading or viewing a film, to activate prior knowledge, to provide a conceptual framework for integrating new information, and to encourage student prediction. **During** instruction, they can help students to actively process and reorganize information. And **after** instruction, graphic organizers may be used to summarize learning, encourage elaboration, help organize ideas for writing, provide a structure for review, and assess the degree of student understanding.

When introducing students to a new graphic organizer, teachers should describe its purpose, model its use, and provide students with opportunities for guided practice. Once students become comfortable with using the organizer, more independent applications are appropriate. Finally, teachers can then encourage students to create their own organizers.

The difference between good and poor learners is not the sheer quantity of what the good learner learns, but rather the good learner's ability to organize and use information.

Frank Smith

REFERENCES:

Anders, P. L., Bos C. S., and Filip, D. (1984). The effect of semantic feature analysis on the reading comprehension of learning disabled students. In J.A. Niles and L.A. Harris (Eds.), Changing Perspectives on Reading/Language Processing and Instruction (pp. 162-166). Rochester, N.Y.: The National Reading Conference.

Semantic feature analysis as compared to traditional vocabulary "look-up" activities gave structure to discussions for learning-disabled adolescents and resulted in significantly better performance on measures of comprehension and concept learning.

Armbruster, B. and Anderson, R. (1980). The Effect of Mapping on Free Recall of Expository Text (Technical report 160). Center for the Study of Reading, University of Illinois, Urbana-Champaign.

This study examined the effectiveness of the use of "mapping" techniques for eighth grade students. The results showed that students who mapped short expository prose passages recalled a greater number of ideas from the passage after a twenty-four hour delay than did the control groups. Also, the probability of recalling ideas that have been organized into a map was significantly greater than the probability of recalling ideas which were not organized in this fashion.

Chi, M. (1985). Interactive roles of knowledge and strategies in the development of organized sorting and recall. In S.F. Chipman, J.W. Segal, & R. Glaser (Eds.), Thinking and learning skills, Vol. 2: Research and open questions. Hillsdale, NJ: Lawrence Erlbaum Associates.

The author reviews research with children and adults demonstrating that "category clustering" (grouping items based on perceived similarities) leads to greater recall, and that children as young as 3 years old have some ability to use clusters to aid recall. The research studies presented here, working with children ages 4-8, demonstrate that the more one's knowledge is organized into schemas, or organized frameworks, the easier it is to remember and extend that knowledge.

Dansereau, D.F. (1985). Learning strategy research. In J.W. Segal, S.F. Chipman, & R. Glaser (Eds.), Thinking and learning skills, Vol. 1: Relating instruction to research. Hillsdale, NJ: Lawrence Erlbaum Associates.

This research involved college students in a "Techniques of College Learning" class. Two matched groups of students studied a passage from a geology text. Students in the experimental group received instruction on conceptual frames for understanding scientific theories (a "knowledge schema"); control group subjects received instruction in concentration management. Students in the treatment group outperformed control subjects on an essay-format posttest that assessed recall and comprehension of the text material.

Hagan-Heimlich, J. E. and Pittelman, S.D. (1984). Classroom Applications of the Semantic Mapping Procedure in Reading and Writing. (Program Report 84-4).

This report reviews the theory and research relevant to semantic mapping and gives examples of classroom applications.

Jones, B.F., Amiran, M., & Katims, M. (1985). Teaching cognitive strategies and text structures within language arts programs. In J.W. Segal, S.F. Chipman, & R. Glaser (Eds.), Thinking and learning skills, Vol. 1: Relating instruction to research. Hillsdale, NJ: Lawrence Erlbaum Associates.

In studies using college students and seventh-grade students, those who had received training in "matrix outlining and analysis" (a form of graphic organizer) outperformed control subjects in both recall of unordered information about a topic of instruction and essay writing on that topic.

GRAPHIC REPRESENTATIONS

FINDING:

Teachers who teach students to structure and process information through the use of graphic representation strategies promote learning because graphic representation of material to be learned facilitates comprehension and recall.

RATIONALE:

Graphic representation strategies are learning aids that create symbolically a picture of the structure and relationships of material, most frequently material found in textual form. The form of the graphics themselves mimics psychologists' theoretical view of how information units and structures of units are embedded in memory. Studies suggest that producing graphic representations effectively increases learners' comprehension and recall.

In the literature on learning, four major graphic representation strategies are found. (1) A networking strategy requires students to depict the relationships among the concepts or ideas in a passage of text in the form of a diagram using nodes for concepts and links for relationships. (2) A mapping strategy requires students to use a set of predetermined symbols to represent how ideas in a textual passage are related. The symbols may indicate that one item is an example of another, is caused by another, occured before another, and so on. (3) A concept mapping strategy requires students to identify elements of the content in a passage, then note them in order from general to detailed, moving from top to bottom of a page. Then all items are linked by lines marked to indicate the type of relationship connecting the items. (4) An iconic strategy allows students to create personalized representations through drawings or sketches. It is important to note that in all instances students must be taught to use the strategy.

The effectiveness of graphic representation strategies in aiding recall and comprehension rests on several axioms from research and theory. First, studies consistently show that the more actively students process or interact with material to be learned the greater the learning. Second, studies consistently show that the more organized material is, and the more clearly its organization is perceived by the learner, the greater the learning. Third, studies suggest that under some circumstances visual displays or diagrams accompanying prose presentations facilitate learning. The use of graphic representation strategies by students appears to establish all of these conditions associated with improved comprehension and recall.

Graphic representation strategies have found uses in classrooms from elementary schools to colleges. They are used as advance organizers

and summarizing devices. They are used by students as study aids and by teachers as evaluation tools to check students' learning. In summary, the technique of graphic representation is proving a versatile as well as effective aid to students' thinking. It has impact in classrooms where content is complex and dependence on text presentations is high.

> ***I like graphic representations because they help me see what I'm thinking.***
>
> **Eighth Grade Student**

REFERENCES:

Anderson, R., Spiro, R., and Anderson, M. (1978). Schematic scaffolding for the representation of information in connected discourse. American Educational Research Journal, 15, 433-440.

This article describes an experiment testing the hypothesis that information that is significant in the light of the conceptual framework within which it is received and interpreted will be better learned. Data supported the hypothesis.

Armbruster, B., and Anderson, T. (1980). The Effect of Mapping on the Free Recall of Expository Text. Technical Report No. 160. Center for the Study of Reading. Urbana, Il.: University of Illinois. ED 182735.

The authors tested the effectiveness of mapping for middle school students who were taught to map short prose passages. Their results theshowed promise of techniques in facilitating recall.

Dansereau, D.F. (1979). Development and evaluation of a learning strategy training program. Journal of Educational Psychology, 71, 64-73.

Dansereau reported on interactive learning strategy system including networking strategy for graphically depicting organization of text passages. Data showed effectiveness of strategy.

VanPatten, J., Chun-I Chao, and Reigeluth, C. (1986). A review of strategies for sequencing and synthesizing instruction. Review of Educational Research, 56, 437-471.

This study describes and assesses three different graphic representation strategies for synthesizing conceptual content.

❖ "HIGHER ORDER" QUESTIONING

FINDING:

Teachers who ask "higher order" questions promote learning because these types of questions require students to apply, analyze, synthesize, and evaluate information instead of simply recalling facts.

RATIONALE:

"Higher order" questions may be broadly defined as those questions that require students to go beyond simple recall and engage in more sophisticated thinking. Examples of such questions are provided below:

- How are the two main characters alike and different? (comparison)
- What do you think is the editorial writer's stand on gun control? (analysis, interpretation)
- Should the number of days in the school year be extended? Why or why not? (evaluation)
- What might happen if gasoline prices doubled in the next three months? (prediction)
- In what ways is an argument like an exothemic reaction? (analogical reasoning)

A meta-analysis of 18 experiments by Redfield and Rousseau (1981) concluded that the predominant use of higher-level questions during instruction yielded positive gains on tests of factual recall and application of thinking skills. Andre (1979) reviewed research investigating the effects of having students respond to "higher level" questions that were inserted every few paragraphs in a text. He concluded that such a procedure facilitates better textbook learning than do fact question inserts. However, despite the demonstrated effectiveness of higher cognitive questioning, the majority of classroom questions are factual in nature. In a review of the research on teacher questioning, Gall (1970) and Hare and Pulliam (1980) discovered that only about 20 percent of classroom questions required more than simple factual recall. Goodlad (1983) reports that only about 1 percent of classroom discussion invited students to give their own opinions and reasoning. In an examination of more than 61,000 questions from teacher's guides, student workbooks, and tests for nine history textbooks, more than 95 percent were devoted to factual recall.

Note: In a review of three large correlational studies, Rosenshine (1976) reaches a seemingly contradictory conclusion about the effects of different types of questions. His interpretation determined that students learned best when

teacher questions are "narrow" (factual) and students are given immediate feedback (right or wrong). The apparent disparity can be explained by looking more closely at student population and instructional purpose. Rosenshine's review involved disadvantaged children in the primary grades where development of very basic skills was the primary goal. In this context, it appears that an emphasis on fact questions produces most effective basic skill learning.

> ***In the skillful use of the question more than in anything else lies the fine art of teaching; for in such use we have the guide to clear and vivid ideas, the quick spur to imagination, the stimulus to thought, the incentive to action.***
>
> **Edward deGarmo**

REFERENCES:

Andre, T. (1979). Does answering higher-level questions while reading facilitate productive learning? Review of Educational Research, 49, 280-318.

Andre summarizes what is known about questions as an instructional tool. Among the conclusions made was the effectiveness of higher-order over factual questions to facilitate learning of concepts and principles through reading text materials.

Dillon, J.T. (1984). Research on questioning and discussion. Educational Leadership, 42 (3), 50-56.

In this article, Dillon reviews research on questioning behavior especially related to the use of higher-order questions. Includes discussion of wait time.

Gall, Meredith (1984). Synthesis of research on teacher questioning. Educational Leadership, 42 (3), 40-46.

This thorough review of research on questioning is presented in a practical manner directed toward classroom application. It confirms the importance of asking questions requiring more than simple factual recall.

Redfield, D.L. and Rousseau, E.W. (1981). A meta-analysis of experimental research on teacher questioning behavior. Review of Educational Research, 51, 237-245.

An elaborate statistical treatment applied to the results of major studies on questioning effectiveness during almost two decades reveals the effectiveness of higher-order questions on student achievement.

INQUIRY APPROACH

FINDING:

Teachers who structure learning activities through inquiry methods promote learning because they offer students opportunities to master the forms thinking required for problem solving in the content areas.

RATIONALE:

The inquiry approach is an effective model for developing thinking skills within the context of real situations. The inquiry approach attempts to helps students identify and learn specific strategies for handling data or research problems. It is therefore a powerful tool for initiating students into the types of thinking required in the various disciplines.

A carefully designed inquiry assignment presents students with challenging thinking situations, concrete data to manipulate, and many opportunities for collaborative discussion of the problem situation. Students are coached through important modes of thought/discourse such as careful observation, analysis, definition, etc. This focused attention is very effective in increasing the range of thinking strategies students can apply to problem-solving situations.

For example, one application of the inquiry approach involves having students attempt to develop definitions for concepts which are truly problematic. The teacher would help students work through the processes of identifying positive and negative examples of the concept, analyzing borderline examples, and examining various uses of the concept term.

It must be remembered that the purpose of education is not to fill the minds of students with facts . . . . it is to teach them to think, if that is possible, and always to think for themselves.

Robert Hutchins

REFERENCES:

Hillocks, G. (1979). The effects of observational activities on student writing. Research in the Teaching of English, 13, 23-35.

Hillocks, who is most strongly identified with the inquiry approach as a method of writing instruction, worked with ninth and eleventh graders in this study of descriptive writing. Descriptions of activities working with sets of observation data clearly flesh out the "treatments" which yielded the improvements observed in his experimental group.

Hillocks, G., Kahn, & Johannessen. (1983). Teaching definition strategies as a mode of inquiry: some effects on student writing. Research in the Teaching of English, 17, 275-84.

In this article and in a very useful Theory and Research Into Practice (NCTE), the authors describe an approach to pre-writing activities which emphasizes task analysis and inquiry activities. Activities leading to a definition essay illustrate principles of inquiry teaching.

Smith, D. I. (1974). The effects of class size and individualized instruction on the writing of high school juniors. DAI, 35: 2844-A.

Smith reports a study which blended inquiry with individual tutorial sessions focusing on the analysis of data. Eleventh grade students provided the sample.

Troyka, L. Q. and Nudelman, J. (1975). Taking action: writing, reading, speaking and listening through simulation-games. Englewood Cliffs, NJ: Prentice-Hall.

Troyka reports the effects of role-playing in problem-posing situations. The examination of data from different points of view effectively blends the stress on thinking skills that the inquiry method offers with the interest in audience and social situation that rhetorical approaches to writing offer.

INTRINSIC MOTIVATION AND CREATIVITY

FINDING:

Teachers who motivate their students by emphasizing the inherent rewards of an activity rather than through an emphasis on external evaluation promote learning because intrinsic motivation enhances creative performance.

RATIONALE:

Both children and adults perform more creatively when they do a task that they find inherently interesting. Conversely, both students and adults perform far less creatively when they do a task to earn a reward or avoid a punishment.

When guided by external rewards, we are motivated to do something according to the standards of others. However, this gets in the way of creative performance and also reduces the inherent interest of the activity. For example, if you ask a child who has been offered a toy for making a drawing *why* she is drawing, she will generally reply, "To get a toy." On the other hand, a child who is drawing for the fun of it—perhaps after being reminded how much she enjoys drawing—will typically answer that question differently. At the same time, she will also follow her own standards more in creating her drawing; she will report enjoying the activity more; and she will produce more creative drawings than she would have had she been offered a reward for doing the drawing.

The use of methods of extrinsic motivation, such as rewards or punishments, is a common educational practice that has its place. However, such methods reinforce the external constraints upon performance, reduce intrinsic interest in the task, and *depress* creative performance. Therefore, teachers must decide when they want creative behavior from their students and when they want more conforming behavior. When conformity is desired, extrinsic motivation is powerful, and intrinsic motivation is generally less effective. For example, to get students to learn the rhyme scheme of a sonnet, rewards will be more effective than reminders of the fun of writing poetry. But when creative performance is our objective, we must endeavor to reduce the salience of extrinsic constraints and highlight the intrinsically interesting aspects of the task.

It is nothing short of a miracle that the modern methods of instruction have not yet entirely strangled the holy curiosity of inquiry; for this delicate little plant, aside from stimulation, stands mainly in need of freedom; without this it goes to wreck and ruin without fail. It is a very grave mistake to think that the enjoyment of seeing and searching can be promoted by means of coercion and a sense of duty.

Albert Einstein

REFERENCES:

Amabile, T.M. (1983). The Social Psychology of Creativity. New York: Springer-Verlag.

Amabile reports a series of studies with children of all ages and with adults that show consistently how intrinsic motivation increases creativity and extrinsic motivation inhibits creativity. The experiments, which grew out of work in attribution theory, range across diverse domains. In a typical experiment, Amabile invited creative writers to participate and divided them into three groups, none of whom were told the actual purpose of the study. All groups wrote poems on a given topic, and these poems were judged by independent raters for their creativity. Prior to writing the poems, the poets in the two experimental groups were asked to put in rank order lists of seven reasons why they liked writing poetry. In the *intrinsic* condition, all the reasons on the list were about the intrinsic interest of writing (e.g., "You like to play with words"; "You enjoy the opportunity for self-expression"). In the *extrinsic* condition, all the reasons were about the potential rewards of writing (e.g., "You enjoy public recognition of your work"; "Your teachers and parents have encouraged you to go into writing"). The rankings were not of interest—they were done only to make either intrinsic or extrinsic motives more salient. The results were clear-cut: The *intrinsic* group wrote the most creative poems, followed closely by the control group. The *extrinsic* group's poems were substantially (and significantly) less creative than either of the other groups'. It was common in these studies that extrinsic motivation had a more depressing effect on creative performance than the increased performance that resulted from emphasizing intrinsic motivation. That is, it appears easier to hinder creativity than to nurture it.

Baer, S. (1987). "Teaching for creativity, teaching for conformity." Teaching English in the Two-Year College, 5, 195-204.

This article shows how to apply the research of Amabile and her colleagues to teaching in a particular domain.

LOGICAL THINKING

FINDING:

Teachers who impart the skills and dispositions of logical thinking through direct instruction, discussion, and modeling promote learning because thoughtful analysis of claims and evidence, careful development of one's own arguments, and sensitivity to argumentative fairness are fundamental to critical thinking and informed decision making.

RATIONALE:

Scholars often credit Aristotle with the original formulation of the standards of logical thinking in the West. His work in logic resulted in the development of a set of formal rules for correct reasoning. For example, no matter what content is substituted in place of the letters, the argument form, *All A are B; All B are C; therefore all A are C* will always yield a deductively valid argument. Modern logicians have purified their logical systems even more completely so that the validity of extremely complex arguments can be determined solely on the basis of the relations among formal elements and on the appropriate use of inference rules. This field of study is often referred to as "formal logic."

Although formal logical techniques have revolutionized thinking about the foundations of mathematics and have made computer programming possible, courses in the subject have not proven to yield gains in students' critical thinking abilities. One explanation offered for this failure is that humans do not naturally use formal rules of logic in their thinking; most thinking is done about content, to which these rules are designed to be insensitive. Although no sound argument could violate logical rules, it is doubtful that learning these formal rules insures good reasoning (despite the claims of some logic textbooks).

From an instructional perspective, a concentration on the techniques and practices of informal logic appears more promising. Informal logic explores patterns of argument in natural, "every day" language and concentrates on important components, such as the nature of fallacies, the principles of good reasoning in informal contexts, and the techniques of analyzing complex arguments with implicit assumptions or hidden premises. Instruction in the skills and dispositions of informal reasoning occurs predominantly within college-level courses. However, focused instruction, such as that provided within The Philosophy for Children Program, has been shown to improve the quality of logical thinking in younger students.

Whereas informal logicians tend to focus on argumentation in texts; i.e., arguments that have

already been developed by someone else, cognitive psychologists have studied the differences between good and poor reasoning as it occurs during discussions of "every day" issues. These studies of "informal reasoning" have identified a set of strategies employed by effective reasoners (e.g., being able to argue both sides of a case). Such strategies have been shown to be teachable, resulting in improved abilities to produce evidence-based, nonegocentric arguments.

David Perkins' (1985) research, for instance, employs three criteria of good argumentation: *quality of argument* (as measured on a five-point scale), *lines of arguments* (as measured by the number of reasons provided), and *compensation for objections* (as measured by the number of objections identified and rebutted). Upon testing subjects against these criteria on tasks of everyday argumentation, Perkins concluded that individuals generally produced arguments that were substantially less effective and more biased than one might expect. He found that this was true even for well-educated subjects However, Perkins also observed that focused training in reason elaboration and objection-finding can improve people's reasoning markedly.

Whether it is referred to as "logic," "informal logic," or "informal reasoning," there is evidence to indicate that teachers who provide explicit instruction in appropriate skills, who model the application of logical standards and dispositions, and who provide ample opportunities for students to practice both skills and dispositions improve their students logical thinking abilities.

What comes to us as an intuition may in fact be a prejudice; only by examining such revelations critically can we hope to determine which are which.

John Baer

REFERENCES:

Anderson, J.R. (1980). Cognitive Psychology and its Implications. San Francisco: W.H. Freeman.

In a chapter on deductive reasoning, Anderson examines research evidence that demonstrates:

(1) human reasoning often deviates from the prescriptions of standard logic;
(2) these deviations follow several patterns; and
(3) even brief training in logical deduction and typical logical fallacies can result in improved performance.

He concludes that:

[Humans] would do better if they had more logical training and knew more rules of inference and techniques for analyzing a conclusion. However, in the end, even the most highly trained logicians have to fall back on heuristic techniques to guide their problem-solving efforts in finding a proof. Reasoning is fundamentally a matter of problem solving, not a logical activity. (p. 236)

Gardner, H. (1985). The Mind's New Science: A History of the Cognitive Revolution. New York: Basic Books.

In a very readable chapter entitled "How Rational a Being," Gardner summarizes the work of cognitive scientists (including Kahneman, Tversky, Slovic, and Johnson-Laird) on the problem of human irrationality.

Johnson-Laird, P.N. (1985). In Chipman, S.F., Segal, J.W., & R. Glaser (Eds.), Thinking and learning skills, Vol. 2: Research and Open Questions. Hillsdale, NJ: Lawrence Erlbaum Associates.

Johnson-Laird points to the problem for logical thinking imposed by limitations on working memory:

If my thesis that errors arise largely as a consequence of the limitations of working memory [is correct], then there is perhaps little that can be done pedagogically to enhance logical skill. Yet one should not be too pessimistic. The simple experience of inferential tasks without feedback on performance can lead to significant improvement in performance. The teaching of logic may likewise effect an improvement in performance. (p. 316)

He provides the research evidence to prove these effects, as well as studies that show the effects of creating mental models to solve logical syllogisms. He also points to a way out of the impediment of having limited working memory: training students to use paper and pencil in building models of premises.

Kahneman, D., Slovic, P., & Tversky, A. (Eds.). (1982). Judgment Under Uncertainty: Heuristics and Biases. Cambridge: Cambridge University Press.

In the past decade a great deal of research has undermined the notion that human thinking is essentially logical. The thirty-five chapters in this book demonstrate this and point to some of the underlying judgmental strategies or heuristics humans commonly use. Although these are effective and efficient in many circumstances, all too often they lead to judgmental biases that are large, persistent, and serious in their implications for decision making.

Lipman, M. (1985). "Thinking skills fostered by philosophy for children." In J.W. Segal, S.F. Chipman, & R. Glaser (Eds.), Thinking and learning skills, Vol. 1: Relating instruction to research. Hillsdale, NJ: Lawrence Erlbaum Associates.

A series of studies using the Philosophy for Children program with different age groups have shown an improvement in formal reasoning skills. There were concurrent gains in creative reasoning skills, suggesting that "logical reasoning and intellectual creativity are not mutually inhibitive and that both can be improved by the same program." (p. 104)

Paul R.W. (1985) Dialectical reasoning. In A. Costa (Ed.), Developing Minds: A Resource Book for Teaching Thinking. Association for Supervision and Curriculum Development.

Paul points to three obstacles to the teaching of critical reasoning:

(1) denial of the need;
(2) failure to recognize the difference between the logic of technical problems and the logic of a dialectical nature (the latter is guided by principles of reasoned judgment rather than algorithmic procedures); and
(3) close-mindedness.

Training in the skills and attitudes of dialectical reasoning is the "fundamental task" (p. 160) of education, he concludes.

Perkins, D. (1986, April), Reasoning as it is and could be: an empirical perspective," paper presented at the AERA Conference, San Francisco.

Perkins contends that informal fallacies discussed by philosophers are not those most often made by human subjects, that logical weaknesses are traceable to failings in one of three areas: Quality of Argument, Lines of Argument, and Compensating for Objections. Perkins attempts to show that the use of "scaffolding" techniques in teaching reasoning produce the most impressive gains in informal reasoning abilities in those subjects tested.

METACOGNITION

FINDING:

Teachers who help students develop and internalize metacognitive strategies through direct instruction, modeling, and practice promote learning because the effective use of such strategies is one of the primary differences between more and less able learners.

RATIONALE:

Metacognition refers to the awareness of and control over one's cognitive processes. Effective thinking and learning requires frequent checking, goal-setting, reassessing, and evaluation. Although good thinkers may speed along as if on "automatic pilot" for a time, they also recognize when they have a problem, they spot inconsistencies and mutually incompatible assumptions in their own thinking and that of others, and they know when to consciously apply a variety of problem-solving strategies. One of the key differences between adults' and children's thinking is in the area of metacognition. To help students become effective adult thinkers, we must help them develop metacognitive skills.

Metacognitive skills are many, and any listing of them will produce considerable overlap. Some are quite general, such as "work carefully." Others are more specific, such as "consider opposing points of view before finalizing your decision." Research shows that while students may be aware of certain metacognitive strategies, they often do not understand *when* to apply them. Students need instruction. guidance, and practice to help them learn how to apply effective self-monitoring strategies to academic tasks, such as reading, writing, and problem solving. They also need teachers who are conscious of their own self-monitoring thought processes and can share them with and model them for their students.

The question of which metacognitive strategies to teach to which children is an important issue. This decision will vary according to the nature and demands of the content as well as with the characteristics and needs of the learners. Research evidence suggests a greater need for instruction in metacognitive techniques for lower-achieving learners. At the same time it is important not to overload students with more tools than they are able to carry at once. Because of limitations on working memory, asking students to do too many new things will only result in frustration and failure. As students learn and practice metacognitive strategies, they will gradually internalize these, thereby allowing space in working memory for additional procedures and strategies.

Thoughtful application of metacognitive strategies is central to becoming a more skillful thinker

and accomplished learner. Teachers who help students acquire these skills and an understanding of when to use them enable their students to build a strong foundation for future growth as thinkers.

> ***We often find students following instructions or performing tasks without wondering why they are doing what they are doing. They seldom question themselves about their own learning strategies or evaluate the efficiency of their performance. Some children virtually have no idea what they should do when they confront a problem and are unable to explain their strategies of decision making. There is much evidence, however, to demonstrate that those who perform well on complex cognitive tasks, who are flexible and perserverant in problem solving, who consciously apply their intellectual skills, are those who possess well-developed metacognitive abilities.***
>
> **Arthur Costa**

REFERENCES:

Brown, A.L. (1985). "Mental orthopedics, the training of cognitive skills: An interview with Alfred Binet." In S.F. Chipman, J.W. Segal, & R. Glaser (Eds.), Thinking and learning skills, Vol. 2: Research and open questions. Hillsdale, NJ: Lawrence Erlbaum Associates.

In an addendum to this clever "interview" by means of quotations from one of the pioneers in the measuring and training of intelligence, Brown cites a number of studies that provide "considerable evidence" that training in metacognitive strategies can be successful. These studies "all suggest that combined [training] packages that include such metacognitive supplements to strategy training result in satisfactory maintenance and transfer of the trained skill.... They may be particularly appropriate for children with diagnosed learning problems and a concomitant sense of helplessness in academic milieus" (pp. 335-336).

Brown, A.L. & Palinscar, A.S. (1982). "Inducing strategic learning from texts by means of informed, self-control training." Topics in Learning and Learning Disabilities, 5 (1), 1-17.

This study involved seventh-grade students who were referred by teachers because they were three grades behind their classmates in reading comprehension, although they were able to decode at grade level. Working with tutors, students engaged in an interactive game in which each would take turns leading a dialogue about a segment of text. The dialogue leader would paraphrase the main idea, question any ambiguities, predict possible questions about the seg-

ment, and hypothesize about the remaining content of the passage. Students had difficulty at first learning these metacognitive comprehension-checking activities, but with practice became quite adept. For example, in pre-testing only 11% of subjects' summary statements captured main ideas, but by the end this figure had increased to 60%. In the classroom these students jumped from the 7th to the 50th percentile in comparison with other seventh graders in their school. These effects endured for at least six months, and the authors report that the students typically not only learned the comprehension-fostering strategies, but also internalized them as part of their own cognitive processes for reading.

Carey, S. (1985) "Are children fundamentally different kinds of thinkers and learners than adults?" In S.F. Chipman, J.W. Segal, & R. Glaser (Eds.), Thinking and learning skills, Vol. 2: Research and open questions. Hillsdale, NJ: Lawrence Erlbaum Associates.

Through an examination (and, in several cases, re-interpretation) of the research of Piaget and others, Carey demonstrates that the principal ways in which the thinking of adults and children differs are:

(1) domain-specific knowledge—children's information about and theories of the world differ from adults';
(2) tools of wide application, such as mathematical tools—which she argues may be simply special cases of domain-specific knowledge; and
(3) metaconceptual knowledge—children lack ability to think about their mental representations and inferential processes.

Her analysis highlights the importance of metacognition in learning of all kinds. An example that illustrates the importance of such knowledge is the concept of a *word*. Young children show this in answers to such questions as, "Which word is longer, *snake* or *caterpillar*?" Young children are unable to separate words from their meanings. Metalinguistic tasks such as these are part of reading readiness batteries, she reports, and training in such concepts as *word* and *syllable* helps poor readers to learn to read.

Case, R. (1985). "A developmentally based approach to the problem of instructional design." In S.F. Chipman, J.W. Segal, & R. Glaser (Eds.), Thinking and learning skills, Vol. 2: Research and open questions. Hillsdale, NJ: Lawrence Erlbaum Associates.

Case is concerned with metacognitive "executive control" of thought processes as an instructional objective, and argues that we must not overload working memory by asking students to do too many new things at once. He demonstrates how to assess working memory and how to determine the amount of working memory needed to do solve a particular class of problems. Case's research has been largely in the area of developmental tasks (e.g., maze tracing, quantity examination, conservation, and control of variables), and he reports success in training students to do each of these tasks by breaking them into component parts, training students in each subroutine, providing practice in each subroutine so that it becomes an

automatic process, and then combining the subroutines into a complete problem-solving process. A central feature is providing "sufficient concurrent practice in basic skills so that children can use their working memory for high-level (conceptual) tasks rather than low-level (computational) ones" (p. 561). He also reports research by A.P. Gold in teaching ratio problems of the kind commonly taught in sixth-grade mathematics using the same method.

Costa, A.L. (1985). Teaching for, of, and about thinking. In A.L. Costa (Ed.), Developing minds. Association for Supervision and Curriculum Development: Alexandria, VA., 20-23.

This article summarizes Ron Brandt's concept of a three-part approach for teaching thinking, of which metacognition (as part of teaching about thinking) is a key component.

Garner, R. (1987). Metacognition and Reading Comprehension. Norwood, NJ: Ablex Publishing Corporation.

Garner provides a comprehensive synthesis of research about metacognition and the strategies designed to promote metacognitive behaviors in reading.

Meichenbaum, D. (1985). Teaching thinking: A cognitive-behavioral perspective. In S.F. Chipman, J.W. Segal, & R. Glaser (Eds.), Thinking and learning skills, Vol. 2: Research and open questions. Hillsdale, NJ: Lawrence Erlbaum Associates.

Meichenbaum examines the relationship of metacognition to similar concepts in behavioral and cognitive psychology (such as Skinner's "self-management behaviors" and Neisser's "executive routines"). He quotes Belmont, Butterfield, and Ferretti, who reviewed six studies that focused on teaching executive cognitive skills in which substantial transfer of learning occurred.

The experiments that have produced substantial transfer not only delivered specific instruction in subordinate skills, but also led children to perform, or to see the wisdom of performing activities such as defining goals, designing appropriate plans, and monitoring the implementations and outcomes of those plans (p. 413).

Meichenbaum goes on to show (through a review of related research) that the timing of teaching metacognitive strategies is important. "It is quite likely that training self-regulatory skills will not promote improved performance unless the subskills requisite for the successful execution of the target behaviors are in the child's repertoire (p. 416)."

Palinscar, A.S., & Brown, A.L. (1984). Reciprocal teaching of comprehension-fostering and comprehension-monitoring activities. Cognition and Instruction, 5 (1), 117-175.

Two studies are reported that extend the results of the Brown & Paliscar (1984) study to tutoring with triads and to use by regular classroom teachers with small reading groups (four to seven students) of slow-reading students.

Scardamalia, M., & Bereiter, C. (1985) Fostering the development of self-regulation in children's knowledge processing. In S.F. Chipman, J.W. Segal, & R. Glaser (Eds.), Thinking and learning skills, Vol. 2: Research and open questions. Hillsdale, NJ: Lawrence Erlbaum Associates.

Noting that many "compositional tasks" (which include written composition, but also planning a weekend outing or constructing a scientific theory) cannot be taught at the "algorithmic" level used by Case (cited above) and others, the authors argue for teaching more general problem-solving heuristics. Their strategy is similar to that of Case, however, in their attention to limiting the load on working memory. Rather than give students a full-blown checklist to help them regulate their own compositional process, they first collapse the process into fewer steps, then provide "procedural facilitation" such as giving them a limited set of possible evaluations (e.g., "This is good," "People may not understand this,") rather than a more global directive simply to "evaluate" what one has written. They have been successful in teaching fourth-, sixth- and eighth-grade students to build more complex self-regulatory mechanisms, as evidenced by the quality of students compositions.

Whimbey, A. & Lockhead, J. (1982). Problem-Solving and Comprehension. Philadelphia: Franklin Press.

Whimby and Lockhead report that pairing students to discuss their problem-solving strategies using "think aloud" procedures improved problem-solving capacities significantly.

METACOGNITIVE READING STRATEGIES

FINDING:

Teachers who teach students the *purpose* of reading strategies, *how* to use reading strategies, and *when* to use reading strategies promote learning because knowledge and use of these strategies empowers students to control and improve their own reading comprehension.

RATIONALE:

Studies in which good and poor readers were compared reveal that the more effective readers employ metacognitive strategies before, during, and after their reading in order to facilitate comprehension (Paris & Jacobs, 1984). Poor readers, on the other hand, tend to emphasize decoding ("word barking") rather than reading for meaning. They rarely utilize comprehension-monitoring or "fix up" strategies.

Metacognitive reading strategies can be divided into at least three categories:

1. **planning**—identifying a purpose for reading and selecting particular actions to reach one's reading goals for a passage;
2. **regulation**—monitoring and redirecting one's efforts during the course of reading to reach the desired goals; and
3. **evaluation**—appraisal of one's cognitive abilities to carry out the task and reach one's reading goals.

Each of these aspects of reading awareness includes *declarative* knowledge (e.g., knowing that a title provides clues about the topic of a passage), *procedural* knowledge (e.g., knowing how to summarize), and *conditional* knowledge (e.g., knowing when to skim for details).

Direct instruction in particular reading strategies should be accompanied by (1) convincing explanations of why they can be helpful; (2) instruction in when they should be used; and (3) extensive modeling of the strategies in appropriate reading contexts. Explanations are important to motivate students to use reading strategies (as the use of strategies requires more effort at first). Instruction and modeling are essential because inappropriately applied strategies hinder rather than help reading and will discourage students from using similar strategies in the future. Through explanation and modeling teachers can make it clear to students that these strategies are not "magic" but require practice and effort to develop. Once mastered, the regular application of metacognitive reading strategies can lead to better understanding of text material.

The development of reading (strategies) awareness is an important cognitive attainment because it distinguishes beginning and advanced readers. Skilled readers often engage in deliberate activities that require planful thinking, flexible strategies, and periodic self-monitoring. They think about the topic, look forward and backward in the passage, and check their own understanding as they read. Beginning readers or poor readers do not recruit and use these skills. . . Indeed, novice readers often seem oblivious to these strategies and the need to use them.

S. G. Paris and J. E. Jacobs

REFERENCES:

Brown, A.L. & Palinscar, A.S. (1982). Inducing strategic learning from texts by means of informed, self-control training. Topics in Learning and Learning Disabilities, 5 (1), 1-17.

This study involved seventh-grade students who were referred by teachers because they were three grades behind their classmates in reading comprehension, although they were able to decode at grade level. Working with tutors, students engaged in an interactive game in which each would take turns leading a dialogue about a segment of text. The dialogue leader would paraphrase the main idea, question any ambiguities, predict possible questions about the segment, and hypothesize about the remaining content of the passage. Students had difficulty at first learning these metacognitive comprehension-checking activities, but with practice became quite adept. For example, in pre-testing only 11% of subjects' summary statements captured main ideas, but by the end this figure had increased to 60%. In the classroom these students jumped from the 7th to the 50th percentile in comparison with other seventh graders in their school. These effects endured for at least six months, and the authors report that the students typically not only learned the comprehension-fostering strategies, but also internalized them as part of their own cognitive processes for reading.

Garner, R. (1987). Metacognition and Reading Comprehension. Norwood, NJ: Ablex Publishing Corporation.

Garner provides a comprehensive synthesis of research about metacognition and the strategies designed to promote metacognitive behaviors in reading.

Palinscar, A.S., & Brown, A.L. (1984). Reciprocal teaching of comprehension-fostering and comprehension-monitoring activities. Cognition and Instruction, 1 (5), 117-175.

Two studies are reported that extend the results of the Brown & Paliscar (1984) study to tutoring with triads and to use by regular classroom teachers with small reading groups (four to seven students) of slow-reading students.

Paris, S. G., & Jacobs, J. E. (1984). The benefits of informed instruction for children's reading awareness and comprehension skills. Child Development, 555, 2083-2093.

Eight- and ten-year-old students were interviewed in fall and spring about their awareness of reading strategies. Half of each group received four months of classroom instruction (20-30 minutes twice each week for 14 weeks) in reading strategies. "The lessons taught children about reading comprehension strategies and how, when, and why to use them (p. 2087)." The instruction had three components:

1. explicit instruction in metacognitive strategies;

2. bulletin-board displays portraying reading strategies via metaphors such as "Being a Reading Detective" or "Tracking Down the Main Idea"; and

3. dialogues between teacher and students.

On both pre- and post-assessments, students with greater awareness of reading strategies scored higher on all tests of reading comprehension. In comparisons of matched control groups with groups who received instruction in reading strategies, the experimental group outscored the control group on two comprehension measures (experimenter-designed cloze reading and error detection tests). On a third (a standardized reading comprehension test) there was no difference between groups.

MNEMONICS

FINDING:

Teachers who assist students in learning new information through the use of mnemonic devices promote learning because mnemonics serve a cueing structure to facilitate recall.

RATIONALE:

Working memory - the number of things one can keep in mind at a given time - is limited. For very young children, the limit may be one; for adults it is typically somewhere around seven. When it is exhausted, no new information can enter working memory without "bumping" something out. This does not hopelessly handicap us as thinkers, but requires the development of increasingly more sophisticated thinking and learning strategies. This entails both (1) the "chunking" of groups of items so that they take up only one "space" in working memory, and (2) the automatization of lower-level procedures into higher ones, such that what once took conscious and effortful thought becomes an integral (and generally unconscious) part of a higher-level procedure (and thus no longer requires a separate "space" in working memory).

One practical method for expanding the capacity of working method involves the use of mnemonics. Employing mnemonic devices to jog the memory is as old as ancient Greece and Rome. However, in the last twenty years they have become the focus of more serious inquiry. Much initial research has been done in the context of mastering the vocabulary needed for a second language, but the strategies have been extended to other fields. They have proven helpful in associative learning tasks such as matching capital cities with states, regions or countries, in serial learning tasks such as the various stages in the digestive process, and in the recall of the content of prose passages.

Learners remember new information best when it can be related to and incorporated with existing material already learned. Unfortunately, students are frequently called upon to remember large amounts of disparate and unfamiliar information for which existing memory structures are not readily available. At these times a mnemonic device is a learning aid which can be employed to facilitate memory. The mnemonic aid provides a cueing structure to trigger recall; these structures take the form of words in sentences or rhymes, or of visual images. Descriptions of the most widely used mnemonic devices are provided below.

Rhyme Technique - A technique that employs a familiar rhyme scheme to aid memory. For example, the rhyme, "Thirty days hath September. . . . ," is widely used to help remember the number of days in each month.

Acronym Technique - A technique that involves creating a new word from the first letters of a series of words to be learned. For example, the acronym HOMES may be selected to trigger recall of the names of the Great Lakes.

Link System Technique - A technique that associates words or ideas in order to help learn things in sequence. In order to be memorable, the association should be unusual or even ridiculous. For example, the image of two apples being married may be help to trigger recall of Annapolis as the capital of Maryland.

Rhyming Peg Word Technique - A technique that links a word to be memorized to a number having an associated rhyming word (the peg) and visual image. For example, one = bun, two = shoe, etc. An image of the new word is then associated with the peg word.

The Familiar Place (Loci) Technique - A technique that associates elements of a familiar place, such as the rooms in a home, with items to be memorized.

Key Words Technique - A technique that involves memorizing one or more words from a sentence to help one remember the whole sentence.

Research studies indicate that mnemonic strategies can be taught to students of all ages and learning abilities. Research has also shown that the greatest effect results from learners generating their own mnemonics, but young children and mildly handicapped learners are usually not able to do so, and sometimes the learning task is too difficult to expect this. Nevertheless, retention and recall still improve when the teacher provides the students with an appropriate mnemonic aid.

Mnemonic devices are criticized because they do not help the learner to comprehend and integrate new material into previous learning. No claim is made that they do so. Their sole purpose is to enhance recall. However, when a suitable memory scheme is not available to a student to recall the new information, a mnemonic device may lead to better and more efficiently accomplished learning than a period of rote practice. Also there is some evidence that reliance on the mnemonic aid decreases with repeated usage to trigger a particular information set. When and under what circumstances to provide mnemonic devices to aid students' learning is a judgment call teachers have to make.

"Unfortunately, memory schemes do not always exist in memory for information which must otherwise be remembered. Under these conditions mnemonic devices may be useful. If the learner possesses no scheme for the information presented, then the use of a mnemonic device provides one: a somewhat artificial one perhaps, but one that may result in better learning than the use of rote rehearsal."

F. Belezza

REFERENCES:

Anderson, J.R. (1983). The Architecture of Cognition. Cambridge, MA: Harvard University Press.

Anderson's model of how humans think is one of the most influential in cognitive science, and like most such theories it distinguishes between working memory and long-term memory. Anderson acknowledges the limitiations of working memory and reviews the research concerning how items in working memory (including thought processes) become part of long-term memory. One unsurprising answer is practice: "Every time an item is reentered into working memory it accrues an additional probability of being permanently encoded (p. 172). " Another key to entry into long-term memory is subjects' elaboration on the to-be-remembered material, which is often refered to as "depth of processing".

Belezza, F.S. (1981). Mnemonic devices: classification, characteristics, and criteria. Review of Educational Research, 51, 247-275.

In a review of over 150 studies on use of mnemonics, the author discusses their significance, the nature of effective cueing structures, and methodological problems which make some studies inconclusive.

Higbee, K.L. (1979). Recent research on visual mnemonics: historical roots and educational fruits. Review of Educational Research, 49, 611-629.

Higbee reviews over 100 studies of mnemonics since 1965, and discusses practical implications of mnemonics for education.

Levin, J.R., Shriberg, L.K. and Berry, J.K. (1983). A concrete strategy for remembering abstract prose. American Educational Research Journal, 20, 277-290.

This article reports on four experiments with eighth grade students who were given prose passages describing fictitious towns and illustrations devised to represent designated attributes of these fictitious towns. Keyword illustrations proved to be effective facilitators of students memory and recall of the attributes and of verbatim passages.

Miller, G.A. (1956). The magical number seven, plus or minus two: some limits on our capacity for processing information. Psychological Review, 63, 81-97.

Miller, G.A., Galanter, E., & Pribram, K. (1960). Plans and the Structure of Behavior. New York: Holt, Rinehart & Winston.

Writing about diverse research suggesting that, for adults, seven is about as many items as people can keep reliably in active memory (or the most discriminations adults can reliably make among discrete stimuli), Miller (1956) claims:

"There seems to be some limitation built into us that keeps our channel capacities in this general range [of seven]. On the basis of the present evidence it seems safe to say that we present a finite and rather small capacity for making such. . . [judgments] and that this capacity does not vary a great deal from one sensory attribute to another (p. 86)."

This idea — that there are limitations upon human information-processing capacity — is now a central idea in most theories of how humans think (see Anderson, cited above), and is central to the theory behind the research that supports this finding. This does not limit humans from thinking about more than seven things, but requires a kind of "linguistic recoding," a concept that might include the kind of automatization that Scardamalia & Bereiter and Case try to faciliate. With such automatization (or, in a different context, "chunking" groups of items together), the capacity of the human mind is virtually without limit, as suggested in a later quote from Miller, Galanter, & Pribaum (1960):

"To use a rather far-fetched analogy, it is as if we had to carry all our money in a purse that could only contain seven coins. It doesn't matter to the purse, however, whether these coins are pennies or silver dollars (p. 132)."

Pressley, M. and Dennis-Rounds, J. (1980). Transfer of a mnemonic keyword strategy at two age levels. Journal of Educational Psychology, 72, 575-582.

This experiment demonstrated that keyword method promotes learning in diverse associative tasks, but people must be taught the strategy. Spontaneous transfer of strategy occurs only with older learners.

Pressley, M., Levin, J.R. and Delaney, H.D. (1982). The mnemonic keyword method. Review of Educational Research, 52, 61-91.

This article describes the keyword method and reviews studies demonstrating its effectiveness in numerous contexts.

❖ PROBLEM-SOLVING APPROACH IN SOCIAL STUDIES

FINDING:

Teachers who directly assist students' efforts to solve problems promote learning because students' problem-solving abilities can be improved through explicit instruction.

RATIONALE:

Problem-solving is an instructional strategy that has been used in social studies classrooms for a long time. One reason is that the efficacy of problem-solving as a way to learn has been established. Another, and perhaps more important reason, is that problem-solving is compatible with frequently stated goals of social studies education. Preparing students to function as participating citizens, as flexible thinkers capable of coping with rapid social change, and as independent learners entails developing problem-solving skills and inquiry.

In applying problem-solving strategies in social studies classrooms, teachers frequently have assumed a less directive role than during other types of instruction. They have facilitated but not directly taught; they have relied heavily on student interaction and the task itself to bring students to discover effective processes for problem-solving. Some have followed instructional models that encourage a non-directive approach. Some have assumed that such an approach is inherent in the problem-solving strategy. All too frequently the results have been disappointing and the value of problem-solving as an effective strategy has been called into question.

Current cognitive research has revealed that novice problem solvers are inefficient, but that problem-solving skills are very amenable to training. With this in mind, a limited number of classroom-based experiments have sought to answer the question of whether the problem-solving performance of social studies students can be improved through training. In each instance a program of instruction, wherein the teacher assumed a directive role and engaged in direct teaching, proved more effective in improving the problem-solving performance of students than a program wherein the teacher assumed a supportive role and merely guided "discovery."

What teacher behaviors appear to facilitate students' problem-solving performance? Since research has demonstrated that problem-solving

is very context specific, teachers should:

- identify and make accessible to students the background knowledge required to think meaningfully about the problem;
- present students with functional problem-solving models, explaining why each is appropriate to specific tasks;
- monitor the students' understanding of the interrelationships of the steps in the model; and
- identify skills needed for a problem-solving task and explicitly teach students how to perform these operations. Such instruction should include application of the skill to uncomplicated cases in preparation for applying the skill to the problem-solving task which is the focus of learning.

Evidence suggests that direct instruction can improve the problem-solving performance of students across both age and ability levels. Evidence also suggests that with appropriate teacher direction and involvement, problem-solving can both engage students' interest and stimulate them to higher levels of intellectual endeavor.

The explicit instruction program was a much more powerful influence upon performance than the treatment which primarily relied upon interaction between students and the experience of doing the tasks.

Graham Whitehead

REFERENCES:

Cornbleth, Catherine (1985). Critical thinking and cognitive process. In W.B. Stanley, (Ed.), Review of Research in Social Studies Education: 1976-1983. Bulletin No. 75, Washington, D.C.: National Council for the Social Studies, 11-63.

The author provides an excellent summary of cognitive theory and research on problem-solving.

Curtis, C.K. and Shaver, J.P. (1980). Slow learners and the study of contemporary problems. Social Education, 44, 302-309.

This article describes a study in which problem-solving performance of slow learning high school students was enhanced by direct instruction in skills as compared with control group who showed no similar improvement.

Glenn, A.D. and Ellis, A.F. (1982). Direct and indirect methods of teaching problem solving to elementary school children. Social Education, 46, 134-136.

This article reports the result of a controlled experiment that demonstrated superiority of direct instruction method over "guided discovery" approach in teaching students a problem-solving strategy.

Whitehead, Graham (1978). Enquiry Learning in the Social Studies. ACER Research Series No. 101. Hawthorne, Australia: Australian Council for Educational Research. Ed 164442.

Whitehead describes the design of an extensive study to investigate whether problem-solving abilities of school children could be improved by training. Their results supported the effectiveness of the explicit teaching of problem-solving skills.

PROBING QUESTIONS

FINDING:

Teachers who encourage students to elaborate on and explain their thinking through the use of probing questions promote learning because such questions push students to think more deeply about the topic being discussed.

RATIONALE:

The value of probing questions has long been recognized by educators (e.g., as the key element of a Socratic dialogue), and research confirms this finding. However, research also points out that the use of probing questions is an infrequent practice in many classrooms.

Probing questions, such as *why?*, *can you elaborate?*, *what evidence can you present to support your answer?*, encourage students to "unpack" their thinking, to show how they have reached particular conclusions. Teachers can use probing questions to press students to consider and weigh diverse evidence, to examine the validity of their own deductions and inductions, and to consider opposing points of view. Probing questions ask students to extend their knowledge beyond factual recall and "parroting" of learned theories, to apply what is known to what is unknown, and to elaborate on what is known to deepen their understanding of this knowledge.

Probing questions contribute to a classroom climate of inquiry and thoughtful examination of ideas. Students who are regularly exposed to questions that force them to defend their responses with reasons and evidence may internalize this "critical thinking" habit of mind.

I use the Socratic method here. I ask a question—you answer it. I ask another question—you answer it. Now you may think that you have sufficiently answered the question but you are suffering a delusion. You will never completely answer it.

Professor Kingsley (from the movie, The Paper Chase)

REFERENCES:

Bereiter, C., & Scardamalia, M. (1985). "Cognitive coping strategies and the problem of inert knowledge." In S.F. Chipman, J.W. Segal, & R. Glaser (Eds.), Thinking and learning skills, Vol. 2: Research and open questions. Hillsdale, NJ: Lawrence Erlbaum Associates.

The research presented here documents the problem more than it presents solutions. Through interviews with students and analysis of think-aloud protocols, the authors identify a general coping strategy used by many students that the authors label "knowledge telling"—writing down whatever is remembered about a subject, without any effort to organize or to select (and reject) more and less relevant bits of information. Knowledge telling is an unconsciously learned and applied coping strategy that is "severely limiting to the growth of knowledge (p. 77)." Educators have become unwitting accomplices in its use.

> *Over the years school practices for presenting, reviewing, and assessing knowledge may have accommodated to students' cognitive coping strategy so that finally what is taught is what the knowledge-telling strategy is equipped to handle—and that is, precisely, inert knowledge (p. 77).*

The authors conclude by listing standard school practices (e.g., testing only on specific facts taught in the course) that encourage students to utilize this unthoughtfull strategy.

Krupa, M.P., Selman, R.L., & Jaquette, D.S. (1985). "The development of science explanations in children and adolescents: A structural approach." In S.F. Chipman, J.W. Segal, & R. Glaser (Eds.), Thinking and learning skills, Vol. 2: Research and open questions. Hillsdale, NJ: Lawrence Erlbaum Associates.

Not only do probing questions encourage students to think more deeply, they also show student thinking to which teachers might otherwise be oblivious. In this study of science explanations by students in the first, third, fifth, seventh, ninth and eleventh grades, "subjects' initial explanations may be seen, upon probing, to be more sophisticated than they appear (p. 453)". Students are often thinking and building theories about the facts they learn in class, thinking that is unrecognized and neglected but can be elicited through probing questions.

Newmann, F.M. (1988, March 15). The curriculum of thoughtful classes. Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA.

The goal of this study was to "assess levels of classroom thoughtfulness in ways that would distinguish between lessons that are more and less successful in the promotion of thinking (p. 20)." Two main teacher behaviors emerged: (1) careful consideration of reasons and explanations given by students, and (2) the use of probing, Socratic questioning. Unfortunately, Socratic questioning was also found to be used very rarely in classrooms.

READING, WRITING, THINKING CONNECTIONS

FINDING:

Teachers who integrate instruction in reading, writing, and thinking promote learning because this integrative approach helps students to develop the complementary cognitive processes involved in each.

RATIONALE:

Reading and writing: they are two points in a dialectic of meaning-making with text. "Readers read writing; writers write reading," as the saying goes. There are many connections between the two processes, some simple and easily visible, others complex and highly theoretical. Most visibly, able readers use writing to help them process what they read. Mature readers consuming difficult text might reach for a pencil to make marginal annotations before they even noticed what they're doing. And upon reflection, most of us can recall many experiences where having to write drawing from or reacting to something we've read has deepened our understanding of the reading. And as writers, we are always reading. In addition to reading what others have written — for ideas, for information, for a sense of genre or audience — we also read our own work, over and over, as we revise.

These visible ways that reading and writing complement each other are deepened by research that suggests that they are also complementary processes of meaning-making. Readers are less passive consumers than active composers of meaning as they read. And writers must draw on their knowledge of how different genres are constructed, how different audiences might approach a passage, and how written language holds together in order to write. Finally, reading and writing both tap into "schemata": cognitive structures or scripts for organizing information hierarchically into a meaningful whole. All this suggests that reading and writing, complementary cognitive processes, should be integrated in the classroom.

However, research suggests that reading and writing are often segregated. In the elementary classroom, reading occupies a block in the morning and writing occurs, catch as catch-can, in the afternoon. Middle schoolers might have a reading teacher and a reading class separate from language arts. High schoolers may experience composition and literature as separate courses.

Teachers who want to move toward a greater integration of reading, writing, and thinking should begin by surveying the reading matter in

their classroom. Studies confirm that writers imitate the reading they are introduced to: readers of stilted, unnatural basals write stilted, unnatural prose. Surrounding student writers with well-written models of many genres and styles will enlarge the resources at their disposal when they write. Teachers who call attention to the choices authors make as they write also help students identify with publishing authors and help students to see themselves as able to exercise choices.

Next, teachers should plan writing tasks for readers which will enhance their reading. Many expert readers rely on notational strategies, marginalia, or reflective comments in logs or journals to help them focus on complex selections. Research suggests that these are worthwhile activities if students know how to do them and if they are appropriate to the reading task. Conversely, note-taking and skills sheets which serve merely to check that reading has been done and do not further the reader's struggle with the text impede reading.

Finally teachers should place students into the writer's role and should encourage them to "read like a writer." This phrase recalls that when students are actively engaged in making their own sense of something—in a writing task—their interest in and need for reading changes. Writers read voraciously for information. They probe texts to understand how certain styles are achieved. Studies involving even very young children document the myriad of uses young writers find for what they are reading. Allowing young writers to comb through many books freely, looking for answers to their own questions, and illustrating how the styles and strategies implicit in any reading selection can be generalized to new tasks are two contributions teachers can make to a better integrated reading/writing/thinking environment.

> ***A learner is only a partial biologist, for instance, if he cannot read or write to discover information and meaning in biology. When a student takes the results of his or her observations about lobsters, reads, writes a draft, talks, reads, then writes again, he or she learns what it is to think critically as a biologist.***
>
> **John Guthrie**

REFERENCES:

Jensen, J. (Ed.). (1984). Composing and Comprehending. Urbana, IL: ERIC Clearinghouse on Reading and Communication Skills and National Conference on Research in English.

Jensen edits a collection of 19 essays and research reports exploring the relationship between reading, writing, and reasoning. The pedagogical implications of the research are discussed. Contributors Arthur Applebee, Judith Langer, Carl Bereiter, Robert Tierney and P. David Pearson join the others in arguing that students benefit most from consistent, repeated opportunities to use reading, writing, and reasoning together.

Salvatori, M. (1985). The dialogical nature of basic reading and writing. In D. Bartholomea and A. Petrosky (Eds.), Facts, Artifacts, and Counterfacts. Upper Montclair, N.J.: Boynton Cook.

Salvatori contends that students become engaged in a type of dialectic when they are involved jointly in reading and writing. Students who write in conjunction with reading literature seem to be more critical of their own thinking, as well as of the thinking of the authors they are reading.

Shanklin, N. (1981). Relating Reading and Writing: Developing a Transactional Theory of the Writing Process. Monographs in Language and Reading Studies. Bloomington: Indiana University.

Shanklin reviews a wide range of research from sociolinguistics and psycholinguistics, from composition, from reading research and discourse analysis and from cognitive psychology. Her judgment is that viewed as cognitive processes, reading and writing operate similarly and emphasize the construction of meaning.

Tierney, R. (1986). What is the value of connecting reading and writing? In Convergences: Transactions in Reading and Writing. Urbana, IL: NCTE.

Robert Tierney's opening chapter in the useful collection Convergences summarizes a range of research on the connection between reading skills and writing abilities. He suggests that reading experiences contribute to writing performance and writing experiences contribute to reading performance. In addition, writers acquire values and behavior from reading and readers learn to understand the values and behaviors which are implicit in the texts they read by writing.

Tierney, R., Soter, A., O'Flahavan, J., and McGinley, W. (1989, Spring). The effects of reading and writing upon thinking critically. Reading Research Quarterly, 24 (2), 134-169.

This article describes the results of a study of college undergraduates assigned to one of twelve treatment groups involving combinations of reading, writing, questioning, and knowledge-activating activities related to selected topics. Following the assigned instructional activities, all students composed a "letter to the editor" writing assignment. Analysis of student thinking included ratings of students' letters and revisions, responses to questions, and debriefing comments. The results of this study suggested that reading and writing in combination are more likely to prompt critical thinking than when reading is separated from writing or when reading is combined with knowledge activation or answering questions.

RECIPROCAL TEACHING

FINDING:

Teachers who utilize reciprocal teaching with text materials promote learning because reciprocal teaching actively engages students in the process of "constructing meaning" while promoting the conscious use of effective comprehension strategies.

RATIONALE:

Engaging the thinking of a classroom full of students with different backgrounds, skills, interests, and motivations is difficult. Reciprocal teaching offers an answer. Reciprocal teaching is an instructional procedure developed by Annemarie Palinscar and Ann Brown. This procedure is designed to involve teachers and students in a dialogue about text material, during which four comprehension strategies are actively employed. These strategies, which are spontaneously applied by proficient readers, are summarized below:

1. **Summarizing** — develops the ability to identify the most important information and to communicate it in a succinct fashion.

2. **Questioning** — involves students in thinking about what they don't know, need to know or would like to know about a passage. Generating questions helps to promote purposeful reading.

3. **Clarifying**—emphasizes that the goal of reading is to make sense of the text. When students ask for clarification, they become more aware of potential barriers to comprehension, such as unfamiliar concepts.

4. **Predicting**—requires students to utilize given information and background knowledge to form a hypothesis about where the text "is going." Predicting encourages thoughtful, strategic reading.

When introducing reciprocal teaching, these four strategies are directly presented, explained, and modeled by the teacher. Once students are comfortable with the strategies, they are invited to become "the teacher" and conduct reciprocal teaching dialogues with new text material. At this point the teacher's role shifts from providing direct instruction to monitoring progress and providing feedback. With increasing competence, students are given greater independence from the teacher to work in pairs to coach one another, ask questions, summarize, predict, clarify, and think aloud about what they are reading.

While reciprocal teaching has been successfully applied with students in the primary grades through college, the research indicates that this procedure may be most effective with less proficient readers. This is understandable since the four component strategies of reciprocal teaching are designed to address the types of comprehension difficulties commonly faced by readers. This strategy is especially effective with content/expository text.

> ***. . . reciprocal teaching may provide the clearest and most readily implementable example of gradually releasing task responsibility from teacher to student.***
>
> **P. David Pearson**

REFERENCES:

McDonald, B.A., Dansereau, D.F., Garland, J.C., Holley, C.D., & Collins, K.W. (1979, April). Pair learning and transfer of text processing skills. Paper presented at the meeting of the American Educational Research Association, San Francisco.

In this study, college students worked in pairs with 2500-word college-level textbook excerpts divided into 500-word segments. Both partners read the sections of the text and took turns orally summarizing its contents, with the other partner listening and checking for accuracy of recall. All students then studied individually for a test on another 2500-word text excerpt. Students trained in the pair learning strategy outperformed those not trained in both (1) recall of the texts that they had studied using the pair learning strategy and (2) recall of texts studied on their own after undergoing training. This suggests that not only is pair learning a useful way to study, but also that the skills acquired using this strategy transferred from dyad to individual learning.

Palinscar, A.S., & Brown, A.L. (1984). Reciprocal teaching of comprehension-fostering and comprehension-monitoring activities. Cognition and Instruction, 1, 117-175.

Middle-school children who were extremely poor readers were instructed how to take turns asking questions about what they were reading, summarizing the text, and making predictions about what would be said in the next section of text. Teachers first modelled this behavior in think-aloud form. After several weeks of this, students scored markedly higher on tests of reading comprehension than matched control-group students who engaged in intensive reading practice without reciprocal teaching. Scores on science and social studies tests given in class also rose, and the differences lasted at least eight weeks after the reciprocal teaching experiment ended.

Resnick, L.B. (1987). Education and Learning to Think. Washington, D.C.: National Academy Press, 25-27.

The author includes a summary of the research that supports reciprocal teaching.

RESPONSE TO WRITING

FINDING:

Teachers who respond to student writing in order to guide revision promote learning because they help students to internalize the standards of effective writing.

RATIONALE:

Writers testify to the importance of revision. Like Galway Kinnel's description of what it feels like to write, mature writers seem to pause and reflect often on their developing texts, to match what they've produced with their goals for the project, and to revise both mentally and on the page. Research suggests that one of the more persistent distinctions between beginning writers of any age and expert writers is in the quality of their revising.

Of course, it makes sense. The mind cannot hold at one time all the variables of a writing task. To think about information content, form, audience, and purpose, to consider alternatives in approaches, and to continue to generate more text is virtually an impossibility for anything but the most routine or limited writing tasks. In addition, writers in the act of writing are often so involved with the text as it takes shape that they cannot gain the emotional distance necessary to critically evaluate the success of their efforts. Students need to be taught how revision can proceed, and they need response from teachers and peers during the writing process in order to learn best how to do it.

Teachers who use response to student writing in order to spark revision build many different types of response into the writing classroom, and they provide response throughout the writing process. In fact, if response comes only at the end of an assignment, in the form of an evaluation, the student writer is not helped to revise at all. Although evaluation can help the student understand options for the next assignment, it is quite likely that the next assignment will not present the student writer with the same set of issues she wrestled with in the previous assignment. Therefore, response needs to be available throughout the writing process: response to planning, response to drafts, response to decisions of all kinds.

Since response does not imply teacher evaluation, it can be both formal and informal and can come from many sources. Conferences about work in progress, peer groups discussing drafts or plans, written dialogues in journals, all provide response to work in progress. Student readers and parent readers can offer reactions. The key is that the response should help the writer understand better what he has produced,

how it strikes the reader, and how it might be in the future.

Response should vary depending upon where the writer is in the writing process. Early on writers benefit from talk about their planning and their decisions about how to approach a piece. During drafting, response to how the piece is working on a global level is helpful. At this point, students naturally have their own questions about what they have produced and how a reader would react to it. Response can therefore center on the issues the writer perceives are important. Very late in the writing process when the student is close to a final draft, response might focus on the more particular concerns of style and editing.

Decisions about revision are motivated by response, but should be left firmly in the hands of the writer. When response provides directions for an A,B,C of revision, the student has learned only to follow directions, not to make decisions. Students should, therefore be helped to evaluate the advice they receive from others as they write. As an advice-giver, they should be taught that ownership of the evolving text belongs to the writer, not the responder.

Teachers who create an environment where writers can receive response at many points in the writing process and who teach their students to be effective student responders help their students to internalize criteria for good writing. In revision, the writer raises decisions about text to a level of conscious awareness—effective response plays an important role in doing this. By making decisions about revision and then monitoring the effect of those decisions, writers grow in their judgment about writing.

> ***I start off but I don't know where I'm going. I try this avenue and that avenue, that turns out to be a dead end, this is a dead end, and so on. The search takes a long time and I have to back-track often.***
>
> **Student**

REFERENCES:

Bissex, G. (1982). Writing conferences: alternatives to the red pencil, Learning, 74-77.

Bissex, in an article followed by a companion article by Donald Graves, describes approaches to conferencing in the elementary school which naturalistic research has proven effective in helping students to revise.

Freedman, S. W. (1987). Response to student writing INCTE Research Report No. 231. Urbana, IL: NCTE.

Based on large-scale survey data and lengthy ethnographic observation, Freedman's report argues that teachers who are successful in creating an environment where writers receive the response they need share several characteristics: they leave ownership of the writing in the hands of the student writer, they communicate high expectations for writing by all students, and they provide support without providing formulas or using pre-packaged curricula.

Gere, A. R. and Abbott, R. D. (1985). Talking about writing: The language of writing groups. Research in the Teaching of English, 19, 4, 362-79.

Gere's study reports the power of effective peer response groups in the writing classroom. These groups focus on the substance of pieces brought before the group in contrast with the teacher's primary interest in form.

Purves, A. (1984). The teacher as reader: An anatomy. College English, 46, 259-65.

Purves argues that teachers read student texts with an eye toward detecting error and prescribing instruction in contrast to the way they, as general readers, would read other pieces. Too much response of this kind will skew the writer's growing awareness of audience and sense of power over the developing text. Purves identifies a range of models for teacher response to texts and discusses appropriate uses for each.

Sommers, N. (1982). Responding to student writing. College Composition and Communication, 33, 2, 148-156.

Sommers' study of the commenting style of 35 teachers reveals that teachers' comments often distract writers from their own purposes and focus their attention on teachers' purposes and that many comments were not text specific but could be interchanged with many other drafts. Sommers describes effective comments as those which are linked to ongoing in-class response and revision and as those geared to helping the student to revise rather than toward providing support for evaluation and grades.

❖ TEACHING SCIENTIFIC CONCEPTS

FINDING:

Teachers who teach scientific concepts through a combination of an inquiry approach involving "hands-on" experience and explicit instruction in abstract concepts promote learning because conceptual development is a two-way process, "bottom-up" and "top-down", in which high-level abstract concepts and spontaneously-developed understandings complement each another to form mature, deeply understood scientific concepts.

RATIONALE:

Children spontaneously try to explain things that they experience, and feeding their curiosity with the raw materials of potential scientific discoveries promotes this natural theory-building. By itself, however, it does not lead to a mature understanding of scientific concepts. Similarly, teaching children abstract concepts without engaging their interest and faciliatating their understanding via concrete, experiential examples leads to "shallow" knowledge (or, in many cases, no knowledge at all, as such lessons are quickly forgotten).

Scientific concept building is thus a two-way street. Highly abstract concepts are rarely developed spontaneously; such development requires instruction. Nor can in-depth understanding be gained without a knowledge of concrete examples to fill out the skeleton of an abstract concept.

An inquiry-oriented, "hands on" approach to science instruction stimulates the natural curiousity and theory-building inclination of students, while providing a solid conceptual framework for supporting the development of accurate concepts. Such experiences provide the raw material from which mature scientific theories are constructed.

Discovery learning techniques can provide stimuli to students-as-scientists. Even kindergarten and first-grade students spontaneously explain events, thus beginning the process of concept development. Often these concepts are more elaborate than adults imagine. They are also often incorrect, but they are the framework within which new experiences are understood. Of course, such conceptual frameworks undergo frequent modifications in response to new experiences.

Spontaneously developed concepts tend to remain unarticulated and relatively inaccessible to consciousness, however. Students who are unable to articulate what they know cannot trans-

fer that knowledge beyond the domain in which it was acquired, nor can they evaluate or test these naive theories.

Science teachers, therefore, need to assess the conceptual knowledge of students. They also need to provide "hands on" experiences that will lead students to broaden their understanding. Finally, they need to teach them the more abstract concepts that give this understanding a consciously articulated and systematic framework.

> ***In working its slow way upward, an everyday concept clears a path for the scientific concept and its downward development . . . . Scientific concepts, in turn, supply structures for the upward development of the child's spontaneous concepts toward consciousness and deliberate use.***
>
> **L. Vygotsky**

REFERENCES:

Green, B.F., McCloskey, M., & Caramazza, A. (1985). The relation of knowledge to problem solving, with examples from kinematics. In S.F. Chipman, J.W. Segal, & R. Glaser (Eds.), Thinking and Learning Skills, Vol. 2: Research and Open Questions. Hillsdale, NJ: Lawrence Erlbaum Associates.

This article summarizes previous research by the authors in college students' "commonsense" knowledge of mechanics. "In most cases they are not quite right, and in many cases they are quite wrong (p. 127)." People can get along quite nicely in the world with mistaken scientific notions, however ("It is possible to play catch without being able to explain the ball's trajectory [p. 128]"), and the misconceptions we form may persist in the face of counterfactual evidence. The authors are especially concerned about the need for teachers to confront students' naive conceptions directly, and both to teach and to demonstrate why scientific concepts are preferable.

Krupa, M.P., Selman, R.L., & Jaquette, D.S. (1985). The development of science explanations in children and adolescents: A structural approach. In S.F. Chipman, J.W. Segal, & R. Glaser (Eds.), Thinking and Learning Skills, Vol. 2: Research and Open Questions. Hillsdale, NJ: Lawrence Erlbaum Associates.

In this study of science explanations by students in the first, third, fifth, seventh, ninth, and eleventh grades, "subjects' initial explanations may be seen, upon probing, to be more sophisticated than they appear (p. 453)." Students are often thinking and building theories about the facts they learn in class, thinking that is unrecognized and neglected but can be elicited

through probing questions. But "students' construction of these concepts is aided by educational experience (p. 453)." Teachers need to provide students with both raw material for theory-building (as in discovery learning) and structured explanations of abstract principles ("that these theories may change in a systematic way [p. 453])" into accurate and consciously articulated scientific explanations.

Vygotsky, L. (1986). Thought and Language. (A. Kozulin, Trans. & Ed.) Cambridge, MA: MIT Press.

Using his own research and that of Piaget and Claparede, as well as the pedagogical writings of Tolstoy and Rousseau, Vygotsky argues persuasively for a two-way process of concept formation. "Spontaneous" concepts are those formed from the bottom up, from experience. "Scientific" concepts are those formed from the top down, from instruction. Spontaneous concepts tend to be unsystematic and generally unstated, if not entirely unconscious. Scientific concepts are abstract and systematic. Each type needs the other: scientific concepts lack the concreteness that makes spontaneous concepts accessible, while spontaneous concepts lack the abstractness and organization that allows conscious testing and understanding. ("A concept can become subject to conscious and deliberate control only when it is part of a system [p. 171]".) Vygotsky presents evidence that the development of scientific concepts runs ahead of the development of spontaneous concepts, as long as the curriculum supplies the necessary material; but he also allows the opposing view, as when he quotes Tolstoy: "To give the pupil new concepts deliberately [without concrete experiences to which to relate them] is, I am convinced, as impossible and futile as teaching a child to walk by the laws of equilibrium (from Tolsoy's Pedagogical Writings, quoted in Vygotsky [1986], p. 151)." Fortunately, this chicken-and-egg dilemma need not be resolved, as the clear message is that both are important. "The development of the child's spontaneous concepts proceeds upwards, and the development of his scientific concepts downward, to a more elementary and concrete level (p. 193)," and this two-way process is on-going and continuous. In a footnoted response (p. 272), Piaget notes the importance of proper timing in introducing abstract concepts, and of providing experiences to nurture the development of spontaneous elaboration on the part of students.

STUDENT-GENERATED QUESTIONS

FINDING:

Teachers who provide instruction and give opportunities for teaching students to generate their own questions about text promote learning because they support students' active involvement with restructuring text and constructing meaning.

RATIONALE:

Student-generated questions allow students to take charge of restructuring text for themselves. Framing questions involves active processing of text and interacting with text meaning. In addition, students who can ask their own questions can check their own comprehension rather than relying on teacher questions and feedback.

There are three promising approaches to teaching students to ask their own questions that have been developed recently: 1) reciprocal teaching, 2) Question Answer Relationships (QAR's), and 3) question cues.

Each of these approaches involves modeling question generation and guiding students' use of the strategy. Question Answer Relationships and question cues involve teaching students taxonomies for questions as well as how to form questions.

Question generating gives the students an opportunity to identify the kind of information that provides the substance for a good question, to frame that question, and then to engage in self-testing. The students become much more involved in the reading activity and in the text when they are posing and answering the questions and not merely responding to teacher or text questions.

Annemarie S. Palinscar and Ann L. Brown

REFERENCES:

Lyman, F. T., Jr. (1987). The think trix: A classroom tool for thinking in response to reading. Reading Issues and Practices: 1987 Yearbook of the State of Maryland International Reading Association Council, 4, 15-18.

Lyman describes a "cognitive tool" for helping students generate meaningful quesions about text.

Palinscar, A. S. and Brown, A. L., (1986). Interactive teaching to promote independent learning from text. The Reading Teacher, 39, 771-777.

In this article the authors provide a description and rationale for the strategy of reciprocal teaching. Generating questions is one of the activities students engage in while using this approach which promotes active processing of text and self-monitoring of one's comprehension.

Raphael, T. E. (1986). Teaching question-answer relationships, revisited. The Reading Teacher, 39, 516-522.

The author presents a rationale for teaching students the relationships between questions and answers. She offers a taxonomy of questions that focus on the interactions between readers and texts promoted by questions. This article also contains specific suggestions for teaching students to use cues to help them understand question answer relationships.

❖ STUDENT-GENERATED SUMMARIES

FINDING:

Teachers who involve students in summarizing newly acquired information promote learning because the active process of summarizing helps to integrate and reinforce the major points of instruction.

RATIONALE:

Frequent summarization serves several functions important to learning. A summary ties together specific items of information and integrates them into broader conceptual frames. Summarization, when done by students themselves, requires active manipulation and processing of the material to be learned. The process of summarizing involves students in actively reviewing information, making it more readily retrievable, hence functional. Summaries present both students and the teacher with an opportunity to monitor comprehension of material presented. Finally, frequent summaries internal to a lesson help cue students to the organizational structure of the lesson and signal transitions from one major point to another.

Students are regularly confronted with content that is abstract, unfamiliar, conceptually laden, replete with detail, and diffuse in scope. They deserve the kinds of assistance with learning that frequent summarization provides. Imaginative teachers can think of many ways to utilize the summarizing process without making it merely routine or boring. They can also explicitly teach students the purposes summaries serve in learning so that students will add summarization to their personal repertoire of learning strategies.

Summary and review integrate and reinforce the learning of major points... these structuring elements not only facilitate memory for the information but allow for its apprehension as an integrative whole with recognition of the relationships between parts.

J. E. Brophy and T. L. Good

REFERENCES:

Brophy, J. E. and Good, T. L. (1986). Teachers behavior and student achievements. In M.C. Wittrock, (Ed.), Handbook of Research on Teaching. N.Y.: Macmillan Publishing Company, 328-375.

Summarizes factors found significant to learning in teacher effectiveness studies. Presents summaries as significant structuring devices.

Gage, N. L. and Berliner, D. C. (1979). Educational Psychology. Chicago: Rand McNally.

A textbook treatment of implications of learning theory for instructional design.

Yager, S., Johnson, D.W. and Johnson, R. T. (1985). Oral discussion, group to individual transfer, and achievement in cooperative learning groups. Journal of Educational Psychology, 77, 60-66.

The authors discuss the "summarizing effect" as one of several positive benefits of oral interaction in cooperative learning groups.

VISUAL IMAGERY

FINDING:

Teachers who teach concepts, rules, and other material to students through the use of imagery techniques promote learning because visual imagery enhances the recall of key ideas and increases comprehension.

RATIONALE:

Imagine a group of primary grade children reading a passage in a text about the season autumn. As they read the sentences and discuss their meaning, the teacher shows them pictures of autumn scenes. Later the children draw their own pictures depicting an autumn scene. These children are using imagery strategies and as a result they will be likely to remember more easily and thoroughly the concept of autumn, its attributes, and related generalizations about the season from the text.

Research has demonstrated that children can successfully use imagery strategies in their learning. Many studies have shown the effectiveness of teaching children concepts through pictures and of generating visual images to accompany other verbal material to be learned. As a result of using visuals, comprehension of the information and recall of key ideas are facilitated.

Other studies confirm that linking visual images to passages in texts aids recall and comprehension of the textual materials as well. This is especially relevant for text-based curricula. It is alos important for those topics that are abstract and need to be made more concrete. Generating mental images helps to do this.

Various types of pictorials or mental images are effective. For very young children, photographs or other pictures appropriate to the information can be presented. Teacher generated pictures or diagrams can be used. Eventually, with appropriate instruction in the task, children can draw their own pictures or images to accompany the information. This is probably effective because it assures that the child is actively processing the information and is doing so in the context of his/her own experience, associations, and stored memory. The resulting image is a very personal one. Finally, as children grow, they can simply picture appropriate visual images in their minds.

By teaching students to use imagery techniques, teachers not only are helping them learn more efectively in the short run, but also are helping them acquire a learning strategy that can aid them in independently directing their own learning in the future.

One picture is worth ten thousand words.

Chinese proverb

REFERENCES:

Higbee, K.L. (1979). Recent research on visual mnemonics: historical roots and educational fruits. Review of Educational Research, 49, 611-629.

This review is based on more than 100 studies on the use of visuals to aid in recall of information. Discusses the implication of visual imagery for how material can best be presented and the kinds of strategies that can be taught to students to increase their learning.

Jantz, R. W. and Klawitter, K. (1985). Early childhood/elementary social studies: a review of recent research. In Wm. B. Stanley, (Ed.), Review of Research in Social Studies Education: 1976-1983.

This review of research discusses the implications of multiple studies of the effectiveness of imagery strategies in promoting the learning of young children.

WAIT TIME

FINDING:

Teachers who provide at least three seconds of silent "wait time" after a teacher question and after a student response promote learning by giving students the necessary opportunity to recall relevant prior knowledge and to formulate thoughtful responses.

RATIONALE:

"Wait time" refers to that period of teacher silence that follows the posing of a question (Wait Time I) as well as that following an initial student response (Wait Time II). Extensive research has consistently demonstrated that the quantity and quality of student verbal responses improve when teachers regularly employ the "wait time" technique. For example, Rowe (1974) analyzed over 300 classroom tape recordings of classroom teachers and discovered a mean Wait Time I of one second and a mean Wait Time II of .9 seconds. However, when the average wait for both types was extended beyond three seconds, a variety of significant improvements were observed. A synthesis of studies of wait time by Tobin and Capie (1980) provides the following summary of student outcome variables:

1. The length of student responses increased.
2. More frequent, unsolicited contributions (relevant to the discussion) were made.
3. An increase in the logical consistency of students' explanations occurred.
4. Students voluntarily increased the use of evidence to support inferences.
5. The incidence of speculative responses increased.
6. The number of questions asked by students.
7. Greater participation by "slower" learners occurred.

These results have been validated at the elementary, middle, high school, and college levels.

In terms of teacher behavior, the following changes resulted from the regular use of the "wait time" technique:

1. The use of "higher-level," evaluative questions increased.
2. The percentage of "teacher talk" decreased.
3. Teachers demonstrated greater response flexibility.
4. Teacher's expectations for the performance of students rated as "slow learners" improved.

One practical and effective means of implementing "wait time" in the classroom has been developed by Dr. Frank Lyman (1981) and his colleagues. This strategy, known as THINK-PAIR-SHARE, structures time to think into a mutli-mode cycle. In this cycle, students *listen* to a question or presentation, which is followed by individual *think* time. During this "wait time" period students are not permitted to converse or to raise their hands to respond. However, they are encouraged to write down or diagram their thoughts. At a designated time, signalled by the teacher, students form *pairs* and exchange thoughts with their partner. The pairing period is then followed up by a *sharing* session often in the form of a class discussion. THINK-PAIR-SHARE combines the well-documented effects of "wait time" with the cognitive and affective benefits of cooperative learning, all within an easily-managed classroom routine.

The wait time variable has intuitive appeal. It makes sense to slow a down a little and give students a chance to think.

Mary Budd Rowe

REFERENCES:

Fagan, E., Hassler, D., and Szabo, M. (1981). Evaluation of questioning strategies in language arts instruction." Research in the Teaching of English, 15, 267-273.

The authors cite research on "wait time" in the context of discussion of questioning strategies.

Lyman, F. (1981). The responsive classroom discussion: the inclusion of all students." Mainstreaming Digest. University of Maryland, College Park, MD.

Lyman discusses several effective reader response strategies for involving all students in thoughtful classroom discussions.

Rowe, M., (1974). Relation of wait-time and rewards to the development language, logic and fate control: a. part one: wait time. Journal of Research in Science Teaching, 11 (2), 81-94. b. part two: rewards. 11 (4), 291-308.

An excellent review of the "wait time" research by the primary researcher.

Tobin, K. and Capie, W. (1980). "The Effects of Teacher Wait Time and Questioning Quality on Middle School Science Achievement." Journal of Research in Science Teaching, 17, 469-475.

The authors provide a comprehensive review of the cognitive and affective benefits of using "wait time."

WRITING AS A PROCESS

FINDING:

Teachers who give students frequent practice in written expression through a program that teaches writing as a process promote learning, for they help young writers achieve fluency and control.

RATIONALE:

Writing is a complex skill. Students who have learned to write as a process of planning, drafting, and revising in stages perform better than students taught any other way. In addition, they address writing tasks more purposefully and explore a wider range of options than students who have not been taught through a process approach.

Learning to write well requires frequent practice. Teachers who create opportunities for students to write about topics that they care about, for varied audiences, and for a range of purposes help provide students with the practice they need. Frequent writing builds familiarity and comfort with writing, contributing to fluency in generating and revising ideas. Frequent practice writing for a range of audiences and purposes builds a foundation of knowledge about the expectations for written products, encouraging students to make better decisions about how to approach new writing tasks.

Good writing assignments rarely occur in isolation; they are part of the fabric of the classroom, drawing on the reading, discussion, and writing that students have been doing together. Good assignments give students some control over the task, allowing them to choose or modify their topics, to draw on a range of knowledge and experience in composing, and to reflect on what they have accomplished with writing. Good assignments also move the class through stages of brainstorming and generating ideas, composing rough drafts, revising rough drafts to improve their effectiveness, and finally editing them for mechanics, conventions, spelling, and grammar.

Within the writing process, teachers have many opportunities to directly teach strategies for writing well. They can teach strategies for generating ideas, methods for revising, and approaches to editing. Grammar and mechanics are best taught as part of the writing process by focusing on the demands of the assignment at hand and the needs of the students. Editing, or the process of refining and correcting the language of a written piece in preparation for publishing, becomes the occasion for instruction in correct usage or in the conventions of punctuation and spelling.

Finally, the teachers who encourage their students to share their writing and to give and receive response to works in progress help their students learn how to support each other as writers. Added to the response of the teacher, this support creates a "culture of writing" where students are challenged to think more deeply about their work, to clarify their ideas, and to value writing. When writing becomes a tool for thinking, teachers of all content areas begin to see how writing assignments can help them teach more effectively.

> ***Clear writing leads to clear thinking; clear thinking is the basis of clear writing. . . . writing holds us responsible for our words and ultimately makes us more thoughtful as human beings.***
>
> **Ernest Boyer**

REFERENCES:

Applebee, A. (1981). Writing in the Secondary School: English and the Content Areas. Research Report No. 21. Urbana, IL: NCTE.

Applebee combined a national survey of practices in teaching writing with observation of how writing was used and taught in secondary classrooms. He concludes that students are given insufficient practice in writing, and particularly in sophisticated uses of writing in secondary schools.

Britton, J, Burgess, T., Martin, N., McLeod, A., and Rosen, H. (1975). The Development of Writing Abilities (11-18). London: Macmillan Education Ltd.

This pioneering study of the uses of writing in British secondary schools awakened educators in both Eritain and America to the limited range of audiences and purposes called upon by writing assignments in schools. It recommends ways to improve the curriculum to support greater growth and development.

Graves, Donald. (1978). Balance the Basics: Let Them Write. New York: Ford Foundation. ED 192 364.

Graves, Donald. (1983). Writing: Teachers and Children at Work. Exeter, NH: Heinemann Educational Books.

Donald Graves describes how focusing on the natural process of student writers can provide the foundation for an elementary school language arts curriculum.

Hillocks, G. (1986). Research on Written Composition: New Directions for Teaching. Urbana, IL: National Conference on Research in English and ERIC Clearinghouse on Reading and Communication Skills.

Hillocks analyzed nearly two thousand studies on the teaching of composition. He concludes that two approaches to teaching writing, an environmental approach and a natural process approach, produce the most significant gains in writing ability. Conversely, the teaching of grammar and the restrictive use of models produced little gain.

Scardemalia, M. and C. Bereiter. (1986). Research on written composition, In M. Wittrock (Ed.) Handbook of Research on Teaching. New York: Macmillan Education.

Scardemalia and Bereiter, in a review of research on written composition conducted since the early 70s, conclude that a crucial factor in mature, expert writing behavior is the ability to draw from a wide range of mental representations of texts and social situations. They argue that frequent practice writing for varied audiences and purposes, as well as instruction that focuses on meaningful goals is essential if young writers are to develop a broad range of text representations.

WRITING TO LEARN

FINDING:

Teachers who encourage their content area students to "write to learn" through well structured assignments and opportunities for expressive writing promote learning because they help students integrate content knowledge with personal knowledge.

RATIONALE:

Much instruction is devoted to helping students to write better; however, writing is a powerful learning tool, and content area teachers (including language arts teachers covering content and English teachers in their role as language/literature specialists) can help students master the techniques of "writing to learn."

The phrase "writing to learn" suggests a host of practices, most of which involve expressive writing. Expressive writing, as defined by James Britton, is writing that is personal, close to the self. It is almost like thought made visible, and is close to notions like "inner speech" and "writer-based prose." When writing expressively, students are concerned with getting it out and getting it down, rather than with writing to please the teacher. Although expressive writing is not the whole of writing instruction, in content classes it can be a powerful tool for students who need to internalize content and to discover a relationship between school content and their own knowledge.

Teachers who use "writing to learn" provide students with frequent opportunities to write expressively in order to wrestle with classroom content. They may require students to keep a content journal where they will be able to write/think freely, without concern about their prose being marked for errors. Teachers might then stop a discussion after an important point has been reached, asking their students to write for five minutes in their logs in order to clarify the points just made. Or, at the end of a class period, students may write briefly to close off questions lingering in their minds. The teacher can then begin the next class period by addressing those questions. Students might conduct long-term observations of some phenomenon through the journal. Or they might respond to challenging "prompts" prepared by the teacher. In their journals, students can take risks they would never take in writing to be corrected.

Although expressive writing promote[s] ... ment with content, studies suggest [that] ... s are provided with little oppor[tunity] ... expressively. The overwhelmin[g] ... in schools is "transactional": a ... tween teacher and student us[ually] ... pose of evaluating what th[e] ...

answer and fill-in-the-blank exercises still dominate many classrooms, and students therefore rarely experience the benefits of expressive writing. In schools where that is the case, students must be eased into journal-writing, and teachers must restrict their comments to supportive and probing responses. Correcting grammar or requiring a particular rhetorical form for responses (i.e. paragraph structure, etc.) diverts students from the thinking task at hand and focuses their attention on 'testable" aspects of the writing.

However, with a supportive, trusting atmosphere virtually students can begin to write expressively as a way to make immediate, long-lasting connections with academic content.

> ***It is easy to explain why students forget so quickly so much that teachers tell them: it is not that the data are irrelevant or that students lack intelligence; teachers simply rarely ask students to use data, except to give it back to them in undigested bits on so-called tests . . . .But, as the teachers and researchers cited here believe, no one learns except by doing: in effect, using information precedes really learning it.***
>
> **Ann Jeffries-Thaiss and Christopher Thaiss**

REFERENCES:

Berthoff, A. (1978). Forming/Thinking/Writing: The Composing Imagination. Montclaire, NJ: Boynton/Cook.

Berthoff, drawing on a substantial rhetorical and philosophical tradition, argues for writing as a way of transforming the chaos of brute experience into creative thought. She proposes writing instruction oriented toward thinking and empowerment.

Britton, J., et al. The Development of Writing Abilities, 11-16. London: Macmillan Education.

Martin, et al., report a groundbreaking study into the uses made of writing in British secondary schools. In addition to offering data on the range and foci of school sponsored writing, they develop an analytic system which highlights writing as a mode of thinking. The uses of expressive writing in content learning are richly explored.

Bruffee, K. (1984). Collaborative learning and the "conversation of mankind." College English, 46 (7), 635-652.

Drawing on Thomas Kuhn and Richard Rorty, Bruffee argues for a view of knowledge as intersubjective and consensual. He then discusses how collaborative learning, which better suits the dynamics of knowledge production and use outside of schools, is an appropriate pedagogy for this conception of knowledge as consensual, justified belief.

Fulwiler, Toby. (1982). Writing: an act of cognition. In New Directions for Teaching and Learning: Teaching Writing in all Disciplines [No. 12] C. W. Griffin (Ed.). San Francisco: Jossey-Bass.

Writing is learning is the motto of the writing-across-the-curriculum movement. Fulwiler explains how writing supports discipline-based cognitive growth and discusses the implications of this for classroom teachers.

Knoblauch, C. H. and Brannon, L. Writing as learning across the curriculum. College English, 45, 465-74.

The authors argue that writing in the content areas should serve as a method of discovery.